2015-2016 Madison Assessment Results

Scientific Reasoning (SR), Quantitative Reasoning (QR), and Natural World (both SR and QR)

Summary:

- 160 WU seniors were tested using the Madison Assessments; Natural World was administered to 58 students, Quantitative Reasoning to 4, and Scientific Reasoning to 98 students. For both NW and QR the average percent correct was 67%, and for SR the mean was 68%.
- The 66 NW items were recoded, and the separate 26 item QR and 49 item SR percent correct scores were calculated (including the 6 SR objectives and 2 QR objectives).

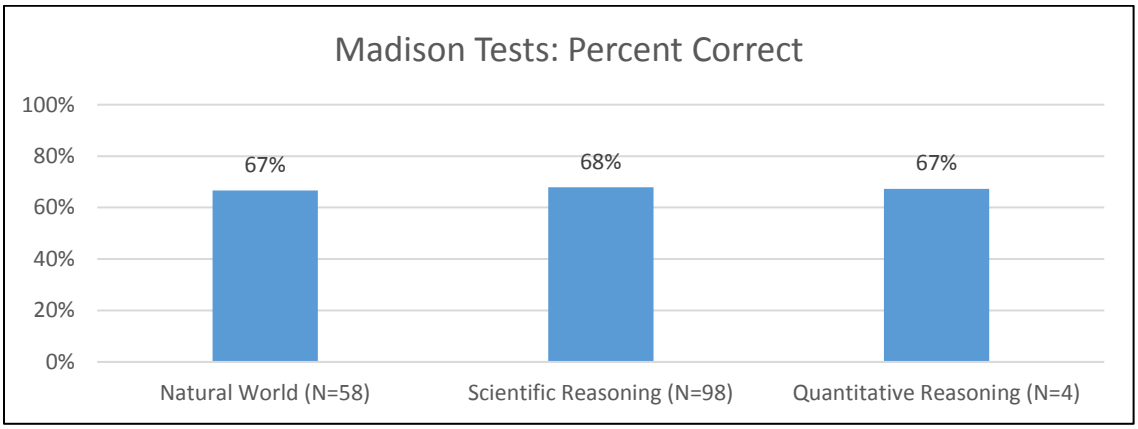
- The mean for Quantitative Reasoning was 68.9% correct but over half (56.5%) of the 62 seniors who participated scored at or above the mean; and the mode or most frequent score was 80.8% correct but approximately 31% scored at or above the mode.
- The mean for Scientific Reasoning was 67.0% correct but over half (54.5%) of the 156 seniors who participated scored at or above the mean; and the mode or most frequent score was 73.5% correct but 41% scored at or above the mode.

- WU seniors performed best on Objective 1 (describing methods of inquiry and distinguishing science from pseudo-science) with a mean of 72% correct; and achieved means of 70% on Objective 7 (formulating hypotheses, identifying relevant variables, and designing experiments) and Objective 6 (discriminating between association and causation, and identifying the types of evidence used to establish causation).
- WU seniors had the lowest performance on Objective 3 (recognizing the interdependence of applied research, basic research, and technology, and how they affect society) with a mean of 60% correct; and only achieved 62% correct on Objective 8 (evaluating the credibility, use, and misuse of scientific and mathematical information) and Objective 2 (using theories and models that help us understand natural phenomena and make predictions).

- The Student Opinion Survey revealed that 52% of respondents agreed or strongly agreed that doing well on the test was important to them, and 67% wanted to know how well they did on the test. Doing well on the test being important to students and wanting to know how well they did on the test were significantly and positively correlated to performance on the SR and QR. The more important test performance was to students, the higher their percent correct score.
- 72% of students tested agreed or strongly agreed that they were able to engage in good effort throughout the test, and 70% gave their best effort on the test. Engaging in good effort throughout the test and giving their best effort on the test were also significantly and positively correlated with SR and QR performance. The more effort students put towards the test, the higher their score.
- 15% of students agreed or strongly agreed that they did NOT give their full attention to the test, and 25% indicated they were NOT curious about how they did on the test relative to others. NOT giving full attention to the test and NOT being curious about how they did on the test relative to others were significantly and negatively correlated to performance on the SR and QR. The more their full attention was NOT given to the test and the more students were NOT curious about how they performed relative to others, the lower their percent correct scores.

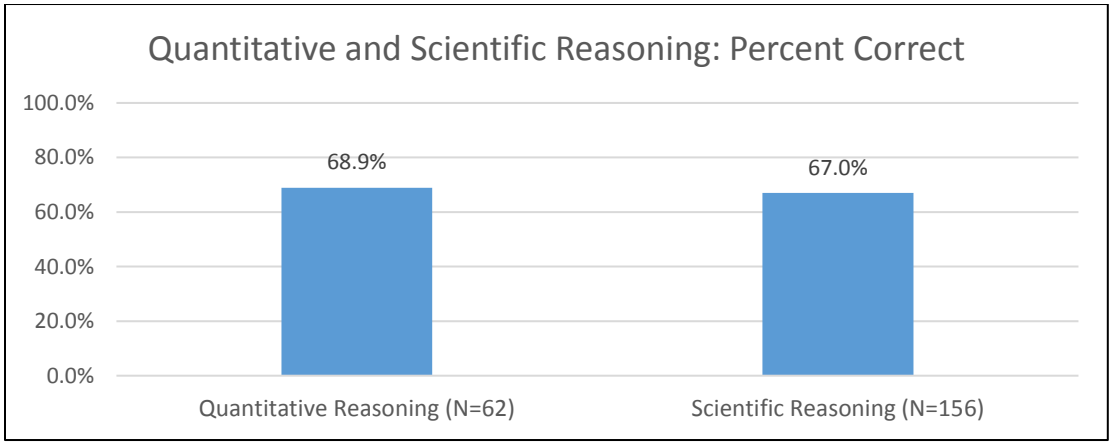
- For all three Madison Assessments combined (Natural World, Quantitative Reasoning, and Scientific Reasoning), the percent correct score was significantly and positively correlated with the total amount of time students spent taking the test. The more time spent on the test, the higher the scores.

Quantitative and Scientific Reasoning is one of Washburn's University-Wide Student Learning Outcomes, and students who were classified as seniors were recruited to be assessed using the Madison Assessments during the 2015-2016 academic year. There are three different tests included in the Madison Assessments: Quantitative Reasoning which consists of 26 items, Scientific Reasoning which consists of 49 items, and Natural World which consists of 66 items assessing both quantitative and scientific reasoning. Fifty-eight seniors were administered the Natural World Test (which assesses both SR and QR), 98 were administered the Scientific Reasoning Test, and 4 seniors were administered the Quantitative Reasoning Test- for a total of 160 seniors tested during 2015-2016. The percent correct for the 58 Natural World Tests ranged from 39% to 89% with a mean of 67%; the percent correct for the 98 Scientific Reasoning Tests ranged from 39% to 94% with a mean of 68%; and the percent correct for the 4 Quantitative Reasoning Tests ranged from 62% to 73% with a mean of 67%.

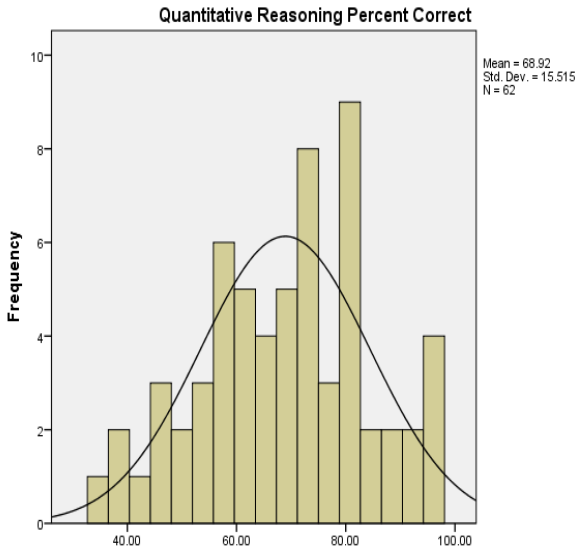


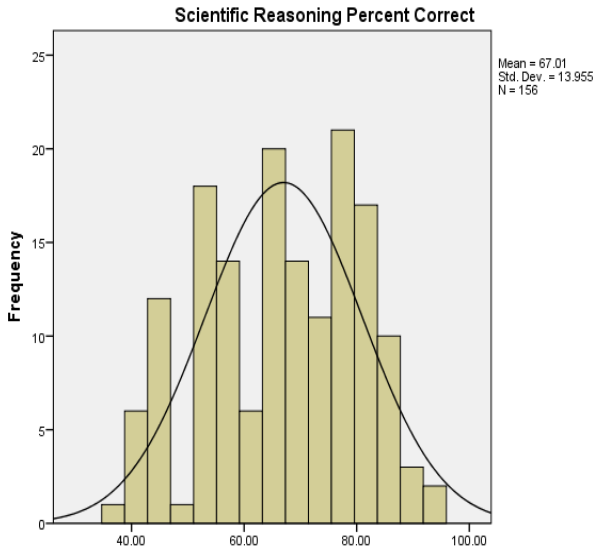
Using the Madison Assessment test blueprints which outlines the types of reasoning being assessed by which test items, the Natural World test items were used to calculate the number correct and the percent correct for Scientific Reasoning and Quantitative Reasoning separately. The 58 NW scores became 58 SR and 58 QR scores, which were added to the 98 existing SR scores and the 4 QR scores, respectively.

The percent correct for the 62 Quantitative Reasoning Tests ranged from 35% to 96% with a mean of 69%; and the percent correct for the 156 Scientific Reasoning Tests ranged from 37% to 94% with a mean of 67%. Washburn University seniors tested seemed to perform slightly better overall in quantitative reasoning than in scientific reasoning.

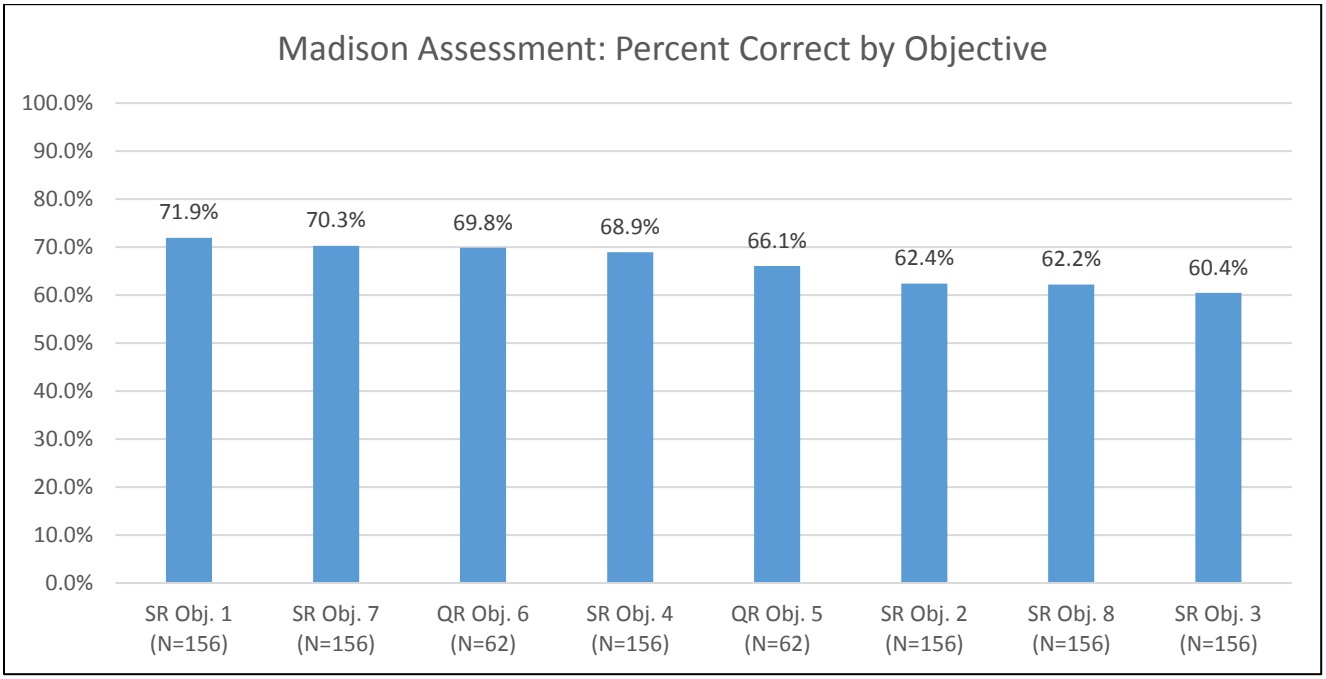


The mean for Quantitative Reasoning was 68.9% correct but over half (56.5%) of the 62 seniors who participated scored at or above the mean; and the mode or most frequent score was 80.8% correct but approximately 31% scored at or above the mode. The mean for Scientific Reasoning was 67.0% correct but over half (54.5%) of the 156 seniors who participated scored at or above the mean; and the mode or most frequent score was 73.5% correct but 41% scored at or above the mode.





The objectives to be measured by the Madison Assessments and their descriptions are consistent across the Natural World, Scientific Reasoning, and Quantitative Reasoning tests (see Appendix A). The items for each test that correspond with each objective, according to test blueprints, were used to calculate the number correct and percent correct for each of the eight objectives. All descriptive statistics for the objective percent correct scores can be found in Table 1.



Washburn University seniors performed best on Objective 1 for Scientific Reasoning (average 72% items correct) which states, "Describe the methods of inquiry that lead to mathematical truth and scientific knowledge and be able to distinguish science from pseudo-science." Scores for the objective ranged from 23% to 100% of the 13 items answered correctly. The mode or most frequent score was 77% and almost 55% of seniors tested scored at or above the mode.

Students achieved a mean of 70% of the 21 items correct on Objective 7 for Scientific Reasoning and of the 10 items on Objective 6 for Quantitative Reasoning. SR Objective 7 states, "Formulate hypotheses, identify relevant variables, and design experiments to test hypotheses." The objective percent correct scores ranged from 29% to 100%, the mode was 76% and almost half (49%) scored at or above the mode. QR Objective 6 states, "Discriminate between association and causation, and identify the types of evidence used to establish causation." The objective percent correct scores ranged from 20% to 100%, the mode was 100%, but over half (53%) scored at or above the mean.

Table 1. Descriptive Statistics for Objective Percent Correct Scores

Obj.	Objective Description	Numb. Items	Numb. Resp.	Mean	Median	Mode	Std. Dev.	Min.	Max.
1-SR	Describe the methods of inquiry that lead to mathematical truth and scientific knowledge and be able to distinguish science from pseudo-science.	13	156	71.9	76.9	76.9	16.15	23.1	100.0
2-SR	Use theories and models as unifying principles that help us understand natural phenomena and make predictions.	7	156	62.4	57.1	71.4	21.78	14.3	100.0
3-SR	Recognize the interdependence of applied research, basic research, and technology, and how they affect society.	7	156	60.4	57.1	57.1	23.17	0.0	100.0
4-SR	Illustrate the interdependence between developments in science and social and ethical issues.	9	156	68.9	66.7	77.8	16.87	22.2	100.0
5-QR	Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomenon.	21	62	66.1	66.7	76.2	16.69	33.3	95.2
6-QR	Discriminate between association and causation, and identify the types of evidence used to establish causation.	10	62	69.8	70.0	100.0	21.31	20.0	100.0
7-SR	Formulate hypotheses, identify relevant variables, and design experiments to test hypotheses.	21	156	70.3	71.4	76.2	16.34	28.6	100.0
8-SR	Evaluate the credibility, use, and misuse of scientific and mathematical information in scientific developments and public-policy issues.	13	156	62.2	61.5	61.5	17.17	23.1	100.0

Objective 4 for Scientific Reasoning, "Illustrate the interdependence between developments in science and social and ethical issues," revealed a mean of 69% of the 9 items answered correctly. Scores ranged between 22% and 100% correct, and 46% of seniors scored at or above the mode of 78%.

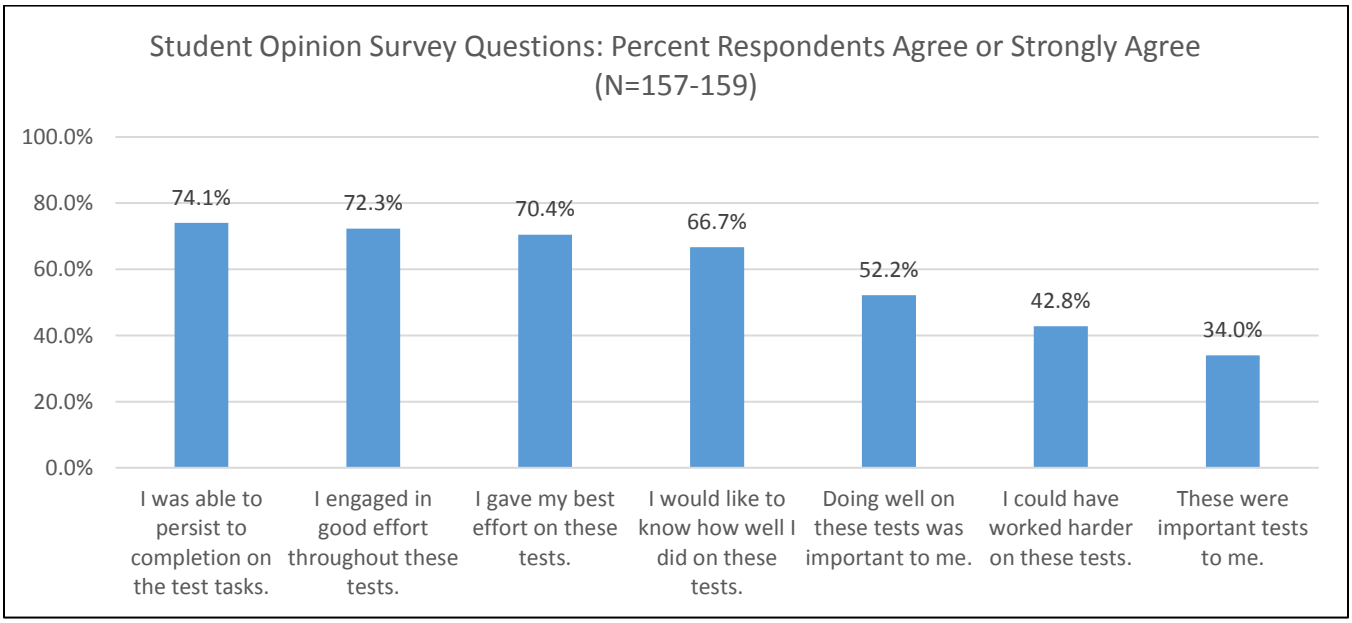
Washburn University seniors achieved 66% of the 21 items answered correctly on Objective 5 for Quantitative Reasoning which states, "Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomenon." Almost 57% of seniors tested scored at or above the mean, and 36% scored at or above the mode of 76% correct.

Students achieved a mean of 62% of the 7 items correct on Objective 2 for Scientific Reasoning and of the 13 items on Objective 8 for Scientific Reasoning. SR Objective 2 states, "Use theories and models as unifying principles that help us understand natural phenomena and make predictions." The objective percent correct scores ranged from 14% to 100%, and the mode was 71% which almost half (49%) scored at or above. SR Objective 8 states, "Evaluate the credibility, use, and misuse of scientific and mathematical information in scientific developments and public-policy issues." The objective percent correct scores ranged from 23% to 100%, and the mode was 62% which 60% of seniors tested scored at or above.

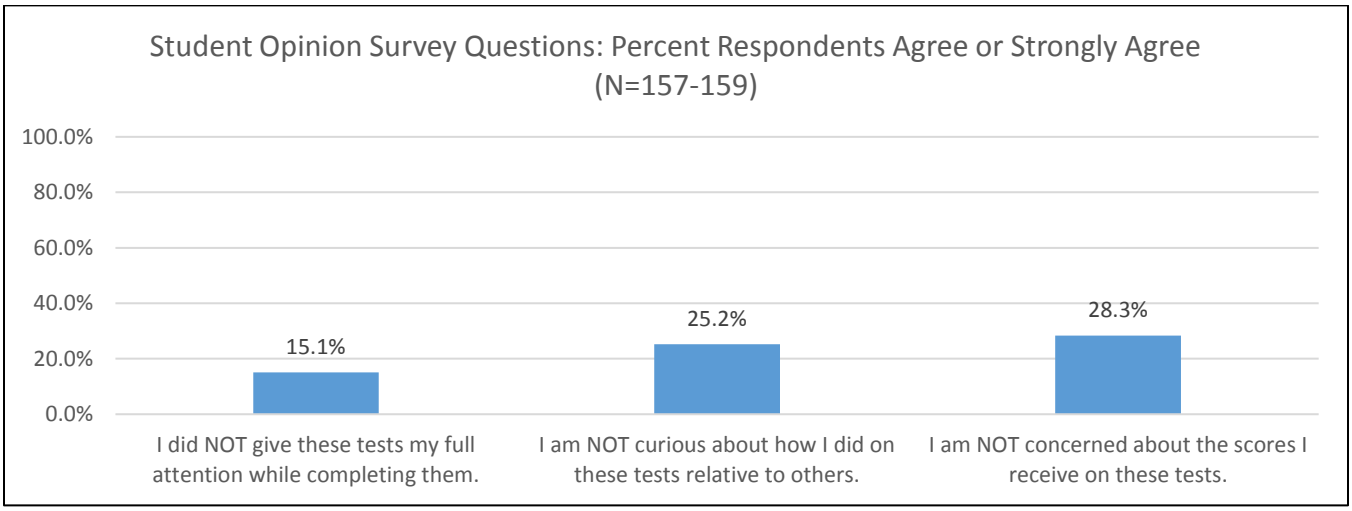
Objective 3 for Scientific Reasoning, "Recognize the interdependence of applied research, basic research, and technology, and how they affect society," revealed a mean of 60% of the 7 items answered correctly. Scores ranged between 0% and 100% correct, and 66% of students scored at or above the mode of 57%.

A 13-item Student Opinion Survey followed the Madison Assessment administered. Three of the survey items pertained to demographic-type information. Of the 159 student survey respondents, 62% indicated they were female and 38% indicated male. Ninety percent of the survey respondents reported that they had completed all of their General Education requirements. Of the 159 survey respondents 77% claimed they had earned over 106 credit hours, 88% had earned over 91, and 94% claimed they had earned over 76 credit hours.

The other ten Student Opinion Survey items asked respondents to indicate the extent to which they agreed with a series of statements pertaining to the Madison Assessment. Approximately 74% of respondents agreed or strongly agreed that they were able to persist to completion on the test tasks, 72% agreed or strongly agreed that they engaged in good effort throughout the test, and 70% agreed or strongly agreed that they gave their best effort on the test. However, 43% of respondents agreed or strongly agreed that they could have worked harder on the test and 15% agreed or strongly agreed that they did NOT give the test their full attention while completing them.



Over 52% of respondents agreed or strongly agreed that doing well on the test was important to them, and 34% agreed or strongly agreed that the test was important to them. Almost 67% agreed or strongly agreed that they would like to know how well they did on the test; but 28% agreed or strongly agreed that they were NOT concerned about the scores they receive on the test and 25% agreed or strongly agreed that they were NOT curious about how they did on the test relative to others.



Bivariate correlations were calculated between the Student Opinion Survey items and the percent correct scores for Scientific Reasoning and Quantitative Reasoning, as well as the percent correct scores for each objective (see Table 2). Doing well on the test being important to the student was significantly and positively correlated to both the percent correct for the SR ($r=0.323$, $p<0.001$) and the QR ($r=0.323$, $p=0.011$) so that the more important doing well on the test was to the student, the higher percent correct score they achieved on the test. The test being important to the student was significantly and positively correlated to the percent correct for the SR ($r=0.249$, $p=0.002$) so that the more important the test was to the student the higher their SR percent correct score. The correlation for the survey item and the QR percent correct was not significant.

Engaging in good effort throughout the test was significantly and positively correlated with both the SR ($r=0.467$, $p<0.001$) and the QR ($r=0.515$, $p<0.001$) scores so students who engaged in better effort throughout the test, had higher their percent correct scores. Giving their best effort on the test was significantly and positively correlated with both the SR ($r=0.427$, $p<0.001$) and the QR ($r=0.421$, $p=0.001$) meaning that giving their best effort was associated with higher percent correct scores on the test. Being able to persist to completing the tasks on the test was significantly and positively correlated with the SR ($r=0.416$, $p<0.001$) so that persisting to complete the test tasks was associated with higher percent correct scores on the SR. The item was not significantly correlated with the QR percent correct scores. Believing they could have worked harder on the test was significantly and negatively correlated with the SR ($r=-0.261$, $p=0.001$) and the QR ($r=-0.364$, $p=0.004$) percent correct scores. This means that the more students reported they could have worked harder on the test, they achieved lower percent correct scores on the tests. Not giving the test their full attention was significantly and negative correlated with the SR ($r=-0.380$, $p<0.001$) and the QR ($r=-0.383$, $p=0.002$) percent correct scores; thus, students who gave less than their full attention to the test tended to have lower percent correct scores.

Table 2. Student Opinion Survey Correlations with Percent Correct Scores by Test and Objective

Student Opinion Survey Items	Scientific Reasoning	Quantitative Reasoning	Obj. 1 SR	Obj. 2 SR	Obj. 3 SR	Obj. 4 SR	Obj. 5 QR	Obj. 6 QR	Obj. 7 SR	Obj. 8 SR
Doing well on these tests was important to me.	.323**	.323*	.198*	.266**	.222**	.244**	.269*	.305*	.292**	.184*
I engaged in good effort throughout these tests.	.467**	.515**	.334**	.357**	.271**	.338**	.440**	.409**	.438**	.296**
I am NOT curious about how I did on these tests relative to others.	-.506**	-.446**	-.360**	-.334**	-.282**	-.400**	-.457**	-.357**	-.491**	-.365**
I am NOT concerned about the scores I receive on these tests.	-.351**	-.221	-.256**	-.245**	-.280**	-.246**	-.200	-.193	-.296**	-.234**
These were important tests to me.	.249**	.202	.181*	.189*	.186*	.155	.176	.160	.234**	.125
I gave my best effort on these tests.	.427**	.421**	.262**	.350**	.288**	.316**	.379**	.309*	.383**	.270**
While taking these examinations I could have worked harder on them.	-.261**	-.364**	-.122	-.218**	-.213**	-.241**	-.335**	-.242	-.191*	-.166*
I would like to know how well I did on these tests.	.557**	.534**	.442**	.374**	.371**	.440**	.490**	.484**	.505**	.360**
I did NOT give these tests my full attention while completing them.	-.380**	-.383**	-.231**	-.281**	-.249**	-.227**	-.326*	-.295*	-.373**	-.248**
While taking these tests I was able to persist to completion of the tasks.	.416**	.249	.381**	.271**	.320**	.313**	.185	.195	.348**	.247**
Scientific Reasoning	1	.761**	.721**	.701**	.629**	.777**	.727**	.768**	.868**	.771**
Quantitative Reasoning	.761**	1	.575**	.467**	.282*	.610**	.969**	.812**	.760**	.711**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The Student Opinion Survey item stating that students would like to know how well they did on the test was significantly and positively correlated with the SR (r=0.557, p<0.001) and the QR (r=0.534, p<0.001) percent correct scores. The stronger students felt about knowing how well they did on the test, the higher their scores tended to be for the SR and QR. The item stating that students were NOT concerned about the scores they received on the tests was significantly and negatively correlated with the SR (r=-0.351, p<0.001) percent correct score, which means those who were not concerned with how they performed on the test achieved lower percent on the SR. The item was not significantly correlated with the QR percent correct score. The survey item regarding students who were NOT concerned about how they did on the test relative to others was significantly and negatively correlated with the SR (r=-0.506, p<0.001) and the QR (r=-0.446, p<0.001) percent correct scores. The more students were not concerned with how they performed relative to others, the lower their percent correct scores.

As can be seen in Table 2, the Scientific Reasoning and Quantitative Reasoning percent correct scores were significantly and positively correlated with each other at r=0.761 (p<0.001). The SR percent correct score was significantly correlated (p<0.001) with the percent correct scores of eight of the objectives ranging from r=0.629 for objective 3 to r=0.868 for objective 7. The QR percent correct score was significantly correlated (p<0.001) with the percent correct scores for seven of the eight objectives ranging from r=0.467 for objective 2 to r=0.969 for objective 5; and objective 3 was significantly correlated (p=0.032) with the QR percent correct at r=0.282.

For all three test types combined, the correlation with the amount of time spent taking the test was significantly positively correlated at r=0.247 (p=0.002), meaning that as students spent more time to complete the tests the percent correct scores increased. When examining the separate test types, only the SR percent correct scores (N=98) are significantly and positively correlated with the amount of time spent on the test at r=0.440 (p<0.001).

Conclusions:

The mean for Quantitative Reasoning was 68.9% correct, but over half (56.5%) who participated scored at or above the mean. The QR mode or most frequent score was 80.8% correct, but approximately 31% scored at or above the mode. The mean for Scientific Reasoning was 67.0% correct, but over half (54.5%) who participated scored at or above the mean. The SR mode or most frequent score was 73.5% correct, but 41% scored at or above the mode. Washburn University seniors who were tested seemed to perform slightly better on the Quantitative Reasoning test than on the Scientific Reasoning. WU seniors performed best on Objective 1 (describing methods of inquiry and distinguishing science from pseudo-science) with a mean of 72% correct; and achieved means of 70% on Objective 7 (formulating hypotheses, identifying relevant variables, and designing experiments) and Objective 6 (discriminating between association and causation, and identifying the types of evidence used to establish causation).WU seniors had the lowest performance on Objective 3 (recognizing the interdependence of applied research, basic research, and technology, and how they affect society) with a mean of 60% correct; and only achieved 62% correct on Objective 8 (evaluating the credibility, use, and misuse of scientific and mathematical information) and Objective 2 (using theories and models that help us understand natural phenomena and make predictions).

The Madison Assessments for Quantitative Reasoning, Scientific Reasoning, and the combined Natural World Assessment are products of Madison Assessment LLC in partnership with the James Madison University (JMU) Center for Assessment and Research Studies (CARS). These organizations distribute and administer assessment testing services to higher educational institutions; and over the past two decades, they have been a recognized industry leader in the development and analysis of assessment testing for higher education institutions. They believe that today's higher education environment demands that institutions be vigilant in assessing their strengths, areas for improvement and their overall efficacy at the program level. However, they do not compile or provide any kind of standardized comparison data due to the fact that the assessments are administered at different types of higher education institutions for a variety of purposes to assorted groups of students with diverse types of testing incentives or requirements. Therefore, the semi-anonymous data collected from the Madison Assessments at higher education institutions is not aggregated or pooled because it is not appropriate to compare the data from different sources with unknown divergence surrounding administration variables. Only longitudinal studies of test scores provide vital information regarding the overall progress and success of the institution's curriculum. Washburn University, following its three-year rotation cycle of assessments, will administer the Madison Natural World Assessment for Quantitative and Scientific Reasoning again during the 2018-2019 academic year.

APPENDIX A. MADISON ASSESSMENT TEST BLUEPRINTS

NATURAL WORLD ASSESSMENT

Obj.	Objective Description	Numb. Items	Items Included
1-SR	Describe the methods of inquiry that lead to mathematical truth and scientific knowledge and be able to distinguish science from pseudo-science.	13	2, 5, 9, 14, 18, 28, 38-41, 55-57
2-SR	Use theories and models as unifying principles that help us understand natural phenomena and make predictions.	7	17, 20, 22, 27, 64-66
3-SR	Recognize the interdependence of applied research, basic research, and technology, and how they affect society.	7	1, 15, 16, 43-46
4-SR	Illustrate the interdependence between developments in science and social and ethical issues.	9	2, 19, 24-26, 29, 55-57
5-QR	Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomenon.	21	4, 7, 8, 10-13, 21, 30-33, 51-53, 58-63
6-QR	Discriminate between association and causation, and identify the types of evidence used to establish causation.	10	3, 34-37, 53, 60-63
7-SR	Formulate hypotheses, identify relevant variables, and design experiments to test hypotheses.	21	5, 6, 9-13, 18, 23, 28, 41, 42, 47-50, 54, 59, 60, 62, 63
8-SR	Evaluate the credibility, use, and misuse of scientific and mathematical information in scientific developments and public-policy issues.	13	2, 14, 24-26, 29, 38-40, 60-63
ALL QR	Quantitative Reasoning	26	3, 4, 7, 8, 10-13, 21, 30-37, 51-53, 58-63
ALL SR	Scientific Reasoning	49	1, 2, 5, 6, 9-20, 22-29, 38-50, 54-57, 59-66
ALL NW	Both Quantitative and Scientific Reasoning	66	1-66

QUANTITATIVE REASONING ASSESSMENT

Obj.	Objective Description	Numb. Items	Items Included
1-QR	Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomenon.	21	2-13, 16-26
2-QR	Discriminate between association and causation, and identify the types of evidence used to establish causation.	10	1, 14-17, 20-23-26
ALL QR	Quantitative Reasoning	26	1-26

SCIENTIFIC REASONING ASSESSMENT

Obj.	Objective Description	Numb. Items	Items Included
1-SR	Describe the methods of inquiry that lead to mathematical truth and scientific knowledge and be able to distinguish science from pseudo-science.	13	2, 3, 5, 10, 14, 23, 25-28, 39-41
2-SR	Use theories and models as unifying principles that help us understand natural phenomena and make predictions.	7	13, 16, 17, 22, 47-49
3-SR	Recognize the interdependence of applied research, basic research, and technology, and how they affect society.	7	1, 11, 12, 30-33
4-SR	Illustrate the interdependence between developments in science and social and ethical issues.	9	2, 15, 19, 20, 21, 24, 39-41
5-SR	Formulate hypotheses, identify relevant variables, and design experiments to test hypotheses.	21	3-9, 14, 18, 23, 28, 29, 34-38, 42, 43, 45, 46
6-SR	Evaluate the credibility, use, and misuse of scientific and mathematical information in scientific developments and public-policy issues.	13	2, 10, 19-21, 24-27, 43-46
ALL SR	Scientific Reasoning	49	1-49