Change Prerequisite and its Impact on Nursing Statistics Course

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Abstract

In 2008 Alberta Education proposed a change of high school mathematics curriculum from the previous Pure Math-10, 20, 30 and Applied Math-10, 20, 30 to Math 10-C, Math 20-1, Math 30-1, Math 20-2, Math 30-2, Math 10-3 Math 20-3 and Math 30-3. The new high school mathematics curriculum was implemented in 2010 and the first group of high school graduates with this new mathematics curriculum got into the post-secondary institutions in 2013.

With the old mathematics curriculum, the prerequisite was Pure Math 30 for the students taking mathematics or statistics courses in science and engineering (including nursing) in any post-secondary institutions in Alberta. With the new mathematics curriculum, the prerequisite is Math 30-1 for the students taking mathematics or statistics courses in science and engineering. A question was raised: "Do we allow the students with Math 30-2 to take introductory statistics for nursing degree program?" By comparing the contents of Math 20-1, Math 30-1 and Math 20-2, Math 30-2, the answer was yes from all the post-secondary institutions in Alberta. As a result, the prerequisite for nursing statistics course has been Math 30-1 or Math 30-2 (changed from the previous Pure Math 30) since 2013. What is the impact with this change of the prerequisite? Is there any difference in statistics course performance between the students with prerequisite Math 30-1 and Math 30-2?

In the past five years, there were about 1000 students taking the nursing statistics course at Mount Royal University. A sample of 279 students regarding their performance in statistics course and prerequisites was gathered. Statistical analyses indicate significant difference between two groups. Some explanations and suggestions are given in this study.

Background

In 2008 Alberta Education proposed a change of high school mathematics curriculum from the previous Pure Math-10, 20, 30 and Applied Math-10, 20, 30 to Math 10-C, Math 20-1, Math 30-1, Math 20-2, Math 30-2, Math 10-3 Math 20-3 and Math 30-3. The new high school mathematics curriculum was implemented in 2010 and the first group of high school graduates with this new mathematics curriculum got into the post-secondary institutions in 2013.

Alberta Mathematics Curriculum

Math 10, Math 20, Math 30

→

Pure Math 10, Pure Math 20, Pure Math 30

Applied Math 10, Applied Math 20, Applied Math 30

→

Math 10-C, Math 20-1, Math 30-1

Math 10-C, Math 20-2, Math 30-2

Math 10-C, Math 20-3, Math 30-3

With the old mathematics curriculum, the prerequisite was Pure Math 30 for the students taking mathematics or statistics courses in science and engineering (including nursing) in any post-secondary institutions in Alberta. With the new mathematics curriculum, the prerequisite is Math 30-1 for the students taking mathematics or statistics courses in science and engineering. A question was raised: "Do we allow the students with Math 30-2 to take introductory statistics for nursing degree program?" By comparing the contents of Math 20-1, Math 30-1 and Math 20-2, Math 30-2, the answer was yes from all the post-secondary institutions in Alberta. As a result, the prerequisite for nursing statistics course has been Math 30-1 or Math 30-2 (changing from the previous Pure Math 30) since 2013.

Prerequisite for Nursing Statistics Course in Alberta Post-Secondary Institutions

Math 30 → Pure Math 30 → Math 30-1 → Math 30-1 or Math 30-2

Questions

What is the impact with this change of the prerequisite?

Is there any difference in statistics course performance between the students with prerequisite Math 30-1 or Math 30-2?

Data Collection

In the past five years, there have been about 1000 students taking the nursing statistics course at Mount Royal University. A sample data of 279 students regarding their performance in statistics course and prerequisites was collected. The variables of consideration are listed below:

Variables:
- Prerequisite (Math 30-1 or Math 30-2)
- High school Mark (Math 30-1 or Math 30-2)
- Test 1 Mark (Nursing Statistics Course)
- Test 2 Mark (Nursing Statistics Course)
- Test 3 Mark (Nursing Statistics Course)
- Minitab Mark (Nursing Statistics Course)
- Final Exam Mark (Nursing Statistics Course)
- Overall Mark (Nursing Statistics Course)

What are the Populations of Study?

There are two populations of study to be considered here. One is all the nursing students taking statistics course at Mount Royal University with prerequisite Math30-1. The other is all the nursing students taking statistics course at Mount Royal University with prerequisite Math30-2. Over the past five years, the sample proportions (by the year) for the students with prerequisite Math30-1 and Math30-2 are summarized in Table I. In the academic year of 2013-2014, about 3/4 of the students had Math30-1 and 1/4 of the students had Math30-2. There was a notable change for 2014-2015 and 2015-2016. For these two years, we had 2/3 of the students with Math30-1 and 1/3 of the students with Math30-2. For the years of 2016-2017 and 2017-2018, the ratio reversed back to 3/4 for Math30-1 and 1/4 for Math30-2. Therefore, our analysis is conducted for the periods of 2013-2016, 2016-2018 and 2013-2018.

Table I: Two Sample Proportions

Count (percent)	Math 30-1	Math 30-2	Total
2013-2014	50 (76.92%)	15 (23.08%)	65
2014-2015	44 (66.67%)	22 (33.33%)	66
2015-2016	34 (66.67%)	17 (33.33%)	51
2016-2017	42 (76.36%)	13 (23.64%)	55
2017-2018	40 (76.92%)	12 (23.08%)	52
Total	210 (72.66%)	79 (27.34%)	289

For the periods of 2013-2016, 2016-2018 and 2013-2018, we have observed some descriptive statistics and have summarized them in Table II-1, Table II-2 and Table II-3. In the second column of each table, (for each item) the first line is the differences of the means of students with prerequisite of Math30-1 and Math30-2. The second line of each item is the differences of the medians.
The remaining parts of the tables are the differences of the means and medians for the marks of their statistics course at Mount Royal University. This includes test 1, test 2, test, Minitab test, final exam and overall marks.

Table II-1 (2013-2016):

Prerequisite		(Math 30-1) – (Math 30-2)
High School Mark:	Mean	-6.93
	Median	-10.00
Test 1 Mark:	Mean	5.26

	Median	5.00
Test 2 Mark:	Mean	10.68
	Median	3.40
Test 3 Mark:	Mean	8.05
	Median	10.00
Minitab Test Mark:	Mean	1.35
	Median	-1.05
Final Exam Mark:	Mean	10.75
	Median	11.85
Overall Mark:	Mean	8.17
	Median	8.55

Table II-2 (2016-2018):

Prerequisite		(Math 30-1) – (Math 30-2)
High School Mark:	Mean	-1.86
	Median	-4.00
Test 1 Mark:	Mean	3.93
	Median	0.00
Test 2 Mark:	Mean	12.75
	Median	13.40
Test 3 Mark:	Mean	15.86
	Median	15.85
Minitab Test Mark:	Mean	9.25
	Median	4.70
Final Exam Mark:	Mean	10.57
	Median	12.50
Overall Mark:	Mean	10.51
	Median	11.30

Table II-3 (2013-2018):

Prerequisite		(Math 30-1) – (Math 30-2)
High School Mark:	Mean	-5.08
	Median	-8.00
Test 1 Mark:	Mean	5.00
	Median	3.40
Test 2 Mark:	Mean	11.33
	Median	13.40
Test 3 Mark:	Mean	10.80

	Median	11.60
Minitab Test Mark:	Mean	4.50
	Median	3.70
Final Exam Mark:	Mean	11.20
	Median	12.50
Overall Mark:	Mean	9.25
	Median	9.50

From the above summary, it is clear (intuitively) that the mean and median of Math 30 marks for the students with Math 30-2 are higher than whose with Math 30-1. On the other hand, the students with Math 30-2 have lower marks in their nursing statistics course than whose with Math 30-1. Are these differences statistically significant? We are conducting the following two groups of hypothesis testing:

Hypothesis I: H_0: mean1 – mean 2 = 0 vs H_a: mean1 – mean2 $\neq$ 0

and

Hypothesis II: H_0: median1 – median 2 = 0 vs H_a: median1 – median2 $\neq$ 0.

Here, mean1 is referring to the mean value of the students with prerequisite Math 30-1 for each of the items considered and mean2 for the students with prerequisite Math 30-2. Similarly, median1 is referring to the median value of the students with prerequisite Math 30-1 for each of the items considered and median2 for the students with prerequisite Math 30-2.

We have conducted the two samples t-test and several non-parametric tests (Mann-Whitney, Kruskal-Wallis and Mood Median Test). The results are summarized into the following tables (Table III-1, Table III-2 and Table III-3):

Table III-1 (2013-2016):

p-value	Two Sample T-Test	Mann-Whitney	Kruskal-Wallis	Mood Median Test
High School	0.000	0.000	0.000	0.009
Test 1	0.019	0.011	0.011	0.435
Test 2	0.001	0.000	0.000	0.005
Test 3	0.028	0.034	0.034	0.021
Minitab Test	0.692	0.722	0.722	0.605
Final Exam	0.001	0.001	0.001	0.004
Overall	0.002	0.002	0.002	0.009

Table III-2 (2016-2018):

p-value	Two Sample T-Test	Mann-Whitney	Kruskal-Wallis	Mood Median Test
High School	0.438	0.609	0.606	0.546
Test 1	0.075	0.083	0.083	0.170
Test 2	0.012	0.004	0.004	0.005
Test 3	0.003	0.000	0.000	0.008
Minitab Test	0.093	0.069	0.068	0.219
Final Exam	0.034	0.016	0.016	0.004
Overall	0.011	0.002	0.002	0.004

Table III-3 (2013-2018):

p-value	Two Sample T-Test	Mann-Whitney	Kruskal-Wallis	Mood Median Test
High School	0.000	0.001	0.001	0.019
Test 1	0.003	0.002	0.002	0.005
Test 2	0.000	0.000	0.000	0.000
Test 3	0.000	0.000	0.000	0.000
Minitab Test	0.116	0.098	0.097	0.027
Final Exam	0.000	0.000	0.000	0.000
Overall	0.000	0.000	0.000	0.000

The hypothesis tests indicate the students having Math30-2 marks are higher than the students having Math-30-1 marks in the mean values and in the median values. Moreover, the differences between them are statistically significant.

The tests also indicate that the students with prerequisite Math 30-1 had higher marks for the nursing statistics course (for all the items under consideration) than the students with Math 30-2. And also the differences between them are statistically significant.

The next question would be “Are the high school Math 30 marks correlated with the nursing statistics course for both the students with Math 30-1 and the students with math 30-2?” We have calculated these correlations and summarized the results into the following tables (Table IV-1, Table IV-2, and Table IV-3):

Some Correlations

Table IV-1 (2013-2016):

Correlation	Math 30-1	Math 30-2	Math 30-1 & Math 30-2
High School vs T1	0.236	0.275	0.182
High School vs T2	0.248	0.267	0.165
High School vs T3	0.175	0.226	0.130
High School vs Minitab	0.321	0.415	0.326
High School vs Final	0.299	0.476	0.255
High School vs Overall	0.317	0.429	0.258

Table IV-2 (2016-2018):

Correlation	Math 30-1	Math 30-2	Math 30-1 & Math 30-2
High School vs T1	0.142	0.232	0.144
High School vs T2	0.390	0.299	0.327
High School vs T3	0.371	0.083	0.258
High School vs Minitab	0.373	0.046	0.200
High School vs Final	0.462	0.331	0.398
High School vs Overall	0.489	0.256	0.374

Table IV-3 (2013-2018):

Correlation	Math 30-1	Math 30-2	Math 30-1 & Math 30-2
High School vs T1	0.213	0.249	0.176
High School vs T2	0.301	0.279	0.224
High School vs T3	0.261	0.190	0.180
High School vs Minitab	0.344	0.287	0.291
High School vs Final	0.381	0.410	0.315
High School vs Overall	0.395	0.367	0.306

All the correlation values are low, which indicates weak correlations between high school math 30 marks and the marks of nursing statistics course taken at Mount Royal University. This may

seemingly contradict to our intuitive impression. As some similar study suggest a high correlation between high school mathematics performance and university calculus performance. A plausible explanation might be university calculus course highly relates to and depend on the high school mathematics knowledge while the nursing statistics course (introductory level statistics course) does not depend on high school mathematics knowledge as much. As long as the statistics course is well taught and properly learned, students should be able to perform well in introductory statistics course that offered by universities.

Conclusion

The data we have collected over the past five years has suggested that the students with prerequisite Math 30-1 have higher marks for the nursing statistics course than the students with Math 30-2. And also the differences between them are statistically significant. However, it does not have significant impact on their success in learning statistics course.

Over the years, the nursing program at Mount Royal University has very high marks for admission. Therefore most students in the nursing program have high mathematics marks in their high schools regardless from Math 30-1 or Math 30-2. In fact, the sample mean value for Math 30-2 is about 7% higher than Math 30-1; and the sample median value for Math 30-2 is about 10% higher than Math 30-1. However, in average, the students with Math 30-1 perform better than the students with Math 30-2 in their introductory statistics course. As most students with Math 30-2 have high Math 30-2 marks from their schools, they are also quite successful in learning statistics course. Therefore, there is not significant impact with the prerequisite change.

When we set Math 30-1 or Math 30-2 as the prerequisite for the nursing statistics course, we do not put the minimum marks needed. Students with marks greater than or equal to 50% for Math 30-1 or Math 30-2 will be allowed to take nursing statistics course. With high admission requirement to get into nursing program, most students have high Math30-2 marks from their high schools. There are a few students fail or withdraw from the nursing statistics course quite often due to the lower Math 30 marks. In the future, if there were more students with lower Math 30-2 marks in the program, their success in the statistics course needs to be observed. If the lower Math 30-2 marks affect their performance and success in the statistics course, a suitable minimum Math 30-2 mark might be needed for the prerequisite. We will keep observing students' performance in the nursing statistics course and make suggestions and recommendations when needed.