

**THE RELATIONSHIP BETWEEN HIGH-RISK COURSES
AND FALL-TO-FALL RETENTION
OF FIRST-TIME, FULL-TIME STUDENTS AT UW**

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The Relationship between High-Risk Courses and Fall-to-Fall Retention of First-Time Full-Time Students at UW

The purpose of this study is to examine the relationship between high-risk courses and fall-to-fall retention of the first-time, full-time students at the University of Wyoming. In this study, a high-risk course was defined as a first-year, for-credit course with 50 or more first-time, full-time students enrolled in five years between Fall 2016 and Fall 2020, with less than 80% of all the enrolled students passing the course. The findings of this study will provide useful information to identify the high-risk courses, improve the student success in these courses, and increase the fall-to-fall retention rate. There were three research questions:

- RQ1: What are the high-risk courses for first-time, full-time students at UW? Who took the most high-risk courses?
- RQ2: Is there a statistically significant association between high-risk courses and fall-to-fall retention?
- RQ3: Considering the other student characteristics, what is the best model (a combination of predictors) to predict first-time, full-time students' fall-to-fall retention?

Key Findings*

High-Risk Courses:

- Overall, 11.4% of courses were considered high-risk.
- STEM courses are more likely to be a high-risk course – 40.4% of the Quantitative Reasoning core course records and 24.6% of the Physical and Natural World core course records were identified as high-risk.
- On average, the number of high-risk courses taken in the first year was 1.08 courses, and students who did *not* retain after 1 year at UW (1.17) took more high-risk courses than those who retained (1.05).
- American Indian or Alaska Native students had the highest average number of high-risk courses in their first year (1.38) and the lowest retention rate (52.4%) among all race/ethnicity groups.
- The group of age 25+ had the highest average number of high-risk courses (1.67) and the lowest retention rate (63.0%) compared to all other age groups.
- The students who took 3 or more high-risk courses had the lowest fall-to-fall retention rate (72.2%). The students who did not take any high-risk courses had the highest retention rate (79.4%).

Significant Positive Predictors:

- Cumulative GPA of Semester 1: Students with a higher cumulative GPA are more likely to retain after 1 year. When a student has a cumulative GPA of 2.3 or higher, the probability of retention is predicted to be 75% or higher.
- Total Number of Courses Taken in the First Year: Students who take more courses are more likely to retain after 1 year. When a student takes 8 or more courses in the first year, the probability of retention is predicted to be 75% or higher.

- High School GPA: Students with higher high school GPA are more likely to retain after 1 year. When a student has a high school GPA of 3.4 or higher, the probability of retention is predicted to be 75% or higher.
- Tuition Residency: Students who pay resident tuition are more likely to retain than those who pay non-resident tuition in the first year.

Significant Negative Predictors:

- First Generation: Students who are *not* first-generation college students are more likely to retain than those who are first-generation college students.
- Number of High-Risk Courses taken in the First Year: Students who take *fewer* high-risk courses are more likely to retain after 1 year. When a student takes 2 or less high-risk courses in the first year, the probability of retention is predicted to be 75% or higher.
- Undeclared Major: Students who are *not* in an undeclared major are more likely to retain after 1 year.

*Students refer to first-time, full-time students in this section.

Methods

Data Source and Sample

The data of first-time, full-time students between Fall 2016 and Fall 2020 cohorts at UW were used in this study. The total of the five years' cohorts included 8,220 students. The demographic information of the students is presented in Table 1.

Data Analysis and Variables

To answer the first research question, the course data of the 8,220 first-time, full-time students were analyzed using descriptive statistics, and the high-risk courses were identified using the criteria including:

- Undergraduate level courses only
- First year courses only
- Credit courses only (attempted credit > 0)
- 5 years total enrollment ≥ 50
- Pass rate < 80%

To answer the second research question, bivariate correlation analyses were conducted using R to investigate if there was a statistically significant association between fall-to-fall retention and the selected student characteristics including how many high-risk courses taken. To answer the third research question, binary logistic regression was conducted using R to investigate the best predictive model of fall-to-fall retention. The dependent (outcome) variable was fall-to-fall retention, and 13 independent (predictor) variables were selected based on literature reviews for the base model (Bass & Ballard, 2012; DeNicco et al., 2015; Djulovic & Li, 2013; Johnson et al., 2020; Ram et al., 2015):

- **Fall-to-fall retention**: whether a first-time, full-time student retained after one year at UW (1 = retained, 0 = not retained)

- **Student demographics:** gender, age at entry, race/ethnicity, first generation, tuition residency
- **High school academic background:** high school GPA and test score (ACT & SAT converted to ACT scale)
- **UW academic experience:** student classification, undeclared major, cumulative GPA of first semester, on-campus or distance education (site code)
- **Courses:** number of courses taken in first year, number of high-risk courses taken in first year.

Data issues were checked before the statistical analyses. The outliers were removed. The intercorrelations of all the independent variables were tested and no multicollinearity issue ($r > 0.8$) was found between any of them.

Table 1

Demographic Information of the First-Time Full-Time Students between Fall 2015 and 2020 Cohorts

Student Characteristics	Fall 2016	Fall 2017	Fall 2018	Fall 2019	Fall 2020	Total
Race/Ethnicity						
American Indian or Alaska Native	8	3	9	11	11	42
Asian	15	24	17	16	23	95
Black or African American	19	19	22	28	23	111
Hispanics of any race	111	114	140	115	77	557
Native Hawaiian or Other Pacific Islander	1	1	3	2	3	10
Nonresident Alien	35	23	22	15	19	114
Race and Ethnicity unknown	112	140	116	132	64	564
Two or more races	69	85	92	69	57	372
White	1,164	1,275	1,428	1,364	1,124	6,355
Gender						
Female	762	823	944	870	729	4,128
Male	772	861	905	882	672	4,092
Age at Entry						
19 and under	1,482	1,622	1,801	1,716	1,355	7,976
20-24	45	51	48	32	41	217
25+	7	11	0	4	5	27
First Generation*						
First Generation	77	485	503	486	390	1,941
Not First Generation	1,457	1,199	1,346	1,266	1,011	6,279
Tuition Residency						
In-State	811	913	908	852	799	4,283
Out-of-State	723	771	941	900	602	3,937
Total	1,534	1,684	1,849	1,752	1,401	8,220

*First generation status is based on the question: Do either of your parents have a 4-year baccalaureate degree?

Findings

RQ1-1: What are the high-risk courses for first-time, full-time students at UW?

There were 77,455 undergraduate-level, for-credit course records that the 8,220 first-time, full-time students took in their first year at UW. Using the criteria above, 21 courses were identified as high-risk courses for first-time, full-time students (Table 2).

Table 2

High-Risk First-Year Courses for First-Time, Full-Time Students at UW

Course	Course Name	Pass		Fail		Incomplete		Withdraw		Total
		#	%	#	%	#	%	#	%	#
LIFE1010	General Biology	2,145	79.6%	310	11.5%	2	0.1%	239	8.9%	2,696
MATH1400	College Algebra	1,191	77.1%	176	11.4%	2	0.1%	175	11.3%	1,544
MATH1405	Trigonometry	618	78.5%	65	8.3%	4	0.5%	100	12.7%	787
MATH925	LC: Algebra II	378	66.8%	125	22.1%	1	0.2%	62	11.0%	566
MATH2350	Business Calc	420	79.7%	48	9.1%	0	0.0%	59	11.2%	527
MATH1000	Problem Solving	281	73.2%	39	10.2%	0	0.0%	64	16.7%	384
COSC1010	Intro Comp Sci I	293	77.5%	44	11.6%	0	0.0%	41	10.8%	378
MATH921	LC: Algebra I	277	79.6%	49	14.1%	0	0.0%	22	6.3%	348
STEP1105*	Academic Success Skills	170	60.5%	73	26.0%	1	0.4%	37	13.2%	281
HIST1221	U.S. From 1865	204	78.8%	31	12.0%	0	0.0%	24	9.3%	259
PHIL1000	Intro to Phil	190	74.8%	34	13.4%	1	0.4%	29	11.4%	254
ECON1400	Sports Economics	101	78.9%	15	11.7%	0	0.0%	12	9.4%	128
AMST2010	Intro to American Studies	80	75.5%	10	9.4%	5	4.7%	11	10.4%	106
ENTO1000	Insect Biology	73	77.7%	8	8.5%	0	0.0%	13	13.8%	94
MATH900	LC: Pre-Algebra	73	77.7%	10	10.6%	0	0.0%	11	11.7%	94
ANTH1450	World Archaeology	62	77.5%	11	13.8%	1	1.3%	6	7.5%	80
EE2800	Problems In: Design Exp w/Devices Problems In: ECE Design Problems In: Physical Computing	57	77.0%	11	14.9%	0	0.0%	6	8.1%	74
UWYO1150	Spec. Topics-Build the Future	54	75.0%	0	0.0%	10	13.9%	8	11.1%	72
GERM1010	1st Yr German I	54	77.1%	6	8.6%	1	1.4%	9	12.9%	70
MUSC1295	Class Piano II	49	76.6%	6	9.4%	0	0.0%	9	14.1%	64
JAPN1010	1st Year Japanese I	39	69.6%	10	17.9%	0	0.0%	7	12.5%	56

Note: *STEP1105 is a probation course

The characteristics of 77,455 course records were analyzed using descriptive statistics. Table 3 compares the high-risk courses (pass rate < 80%) and other courses (pass rate ≥ 80%) based on the course characteristics. Overall, in the 77,455 course records, there were 8,862 records of high-risk courses (11.4%), and 68,593 records of other courses (88.6%).

In the Fall 2016 cohort, students took the highest percentage of high-risk courses. Specifically, 12.4% of 14,510 course records. The percentage of high-risk course records decreased for the next cohort (Fall 2017), but then increased gradually for the following cohort years (Fall 2018 – Fall 2020).

Regarding course delivery methods, 67.3% of the 107 hybrid course records and 12.1% of the 63,789 face-to-face course records were identified as a high-risk course. Only 7.7% of the 13,409 online course records were high-risk.

Core courses are more likely to be a high-risk course because 12.6% of the 55,552 core course records were identified as high-risk, compared to 8.6% of the 21,903 non-core course records. Core courses were identified as courses that meeting the general education requirements. Among the 8 types of core courses, STEM courses are more likely to be a high-risk course because 40.4% of the 8,025 Quantitative Reasoning core course records and 24.6% of the 11,336 Physical and Natural World core course records were high-risk, which were much higher than any other types of core courses including Communication 1-3 (0%), First Year Seminar (0%), Human Culture (4.7%), and US and Wyoming Constitution (5.5%).

Comparing the high-risk percentages of math and English gateway courses, 38.9% of the 8,341 math gateway course records were identified as a high-risk course, and none of the 4,676 English gateway course records were high-risk. Of the 64,438 other non-gateway course records, 8.7% were identified as a high-risk course.

Table 3

Course Characteristics of High-Risk Courses

Course Characteristics	High-Risk Course		Other Courses		Total
	Number	Percent	Number	Percent	Number
Academic Year of the Course Taken					
2016-17	1,806	12.4%	12,704	87.6%	14,510
2017-18	1,708	10.6%	14,345	89.4%	16,053
2018-19	1,955	11.2%	15,523	88.8%	17,478
2019-20	1,874	11.3%	14,746	88.7%	16,620
2020-21	1,519	11.9%	11,275	88.1%	12,794
Delivery Method					
Face-to-face	7,711	12.1%	56,078	87.9%	63,789
Hybrid	72	67.3%	35	32.7%	107
Online	1,036	7.7%	12,373	92.3%	13,409
Unknown	43	28.7%	107	71.3%	150
Core Course*					
Yes	6,985	12.6%	48,567	87.4%	55,552
Communication 1	0	0.0%	4,731	100.0%	4,731
Communication 2	0	0.0%	3,894	100.0%	3,894
Communication 3	0	0.0%	18	100.0%	18
First Year Seminar	0	0.0%	8,105	100.0%	8,105
Human Culture	694	4.7%	14,014	95.3%	14,708
Physical and Natural	2,790	24.6%	8,546	75.4%	11,336
Quantitative Reasoning	3,242	40.4%	4,783	59.6%	8,025
US and WY Constitution	259	5.5%	4,476	94.5%	4,735
No	1,877	8.6%	20,026	91.4%	21,903
Math or English Gateway**					
English gateway	0	0.0%	4,676	100.0%	4,676
Math gateway	3,242	38.9%	5,099	61.1%	8,341
Not gateway	5,620	8.7%	58,818	91.3%	64,438

Grand Total	8,862	11.4%	68,593	88.6%	77,455
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Notes:

*Core courses refer to the general education (USP) courses in this study.

**Gateway math or English courses are the first course for any program to fulfill the single-course college-level math or English requirement. Math gateway courses include MATH 1000, 1400, 1405, 1450, 2200, 2205, 2210, 2350, STAT 2050, 2070. English gateway courses include ENGL 1010, HP 1020.

RQ1-2: Who took the most high-risk courses?

To address the second part of RQ1, the total number of high-risk courses that each student had taken in their first year was computed. Then the means of all students' first-year high-risk courses were computed and compared based on race/ethnicity, gender, age at entry, first generation status, tuition residency, and fall-to-fall retention (Table 4). Overall, the average number of high-risk courses that all 8,220 students took in their first year was 1.08 courses, and students who did not retain after one year at UW (1.17) took more high-risk courses than those who retained (1.05).

Race/Ethnicity

American Indian or Alaska Native students had the highest average number of high-risk courses in their first year (1.38) compared to any other race/ethnicity group. American Indian or Alaska Native students who did not retain after 1 year at UW (1.40) had a higher average number of high-risk courses than those who retained (1.36). The fall-to-fall retention rate of American Indian or Alaska Native students (52.4%) was also the lowest among all race/ethnicity groups.

Gender

Male and female students had the same average number of high-risk courses in their first year at UW (1.08). For the students who retained after one year at UW, male and female students also had the same average number of high-risk courses (1.05). For the students who did not retain after 1 year at UW, both male (1.15) and female students (1.20) had higher average number of high-risk courses than those who retained (1.05).

Age at Entry

Students age 25+ had the highest average number of high-risk courses (1.67) compared to all other age groups, but the sample size of this group was small ($n = 27$). Surprisingly, for students age 25+, those who retained after one year had a higher average number of high-risk courses (1.76) than those who did not retain (1.50). The fall-to-fall retention rate of age 25+ group (63.0%) was the lowest among all age groups.

First-Generation

First-generation students (1.16) took more high-risk courses in their first year than the other students (1.06) on average. Further, first-generation students had a lower retention rate (69.6%) than the other students (79.9%). First-generation students who did not retain after 1 year at UW (1.24) also had a higher average number of high-risk courses than those who retained (1.12).

Tuition Residency

Out-of-state students (1.09) had a slightly higher average number of high-risk courses than in-state students (1.07), and out-of-state students (75.2%) also had lower retention rate than in-state students

Table 4

Average Number of High-Risk Courses in First Year and Retention Rates by Student Characteristics

Student Characteristics	Retained after 1 Year			Not Retained after 1 Year			Total	
	Average # risk courses	Headcount	% of total	Average # risk courses	Headcount	% of total	Average # risk courses	Headcount
Race/Ethnicity								
American Indian or Alaska Native	1.36	22	52.4%	1.40	20	47.6%	1.38	42
Asian	1.16	69	72.6%	1.04	26	27.4%	1.13	95
Black or African American	1.25	85	76.6%	1.08	26	23.4%	1.21	111
Hispanics of any race	1.18	418	75.0%	1.42	139	25.0%	1.24	557
Native Hawaiian or Other Pacific Islander	1.14	7	70.0%	1.67	3	30.0%	1.30	10
Nonresident Alien	0.97	92	80.7%	0.95	22	19.3%	0.96	114
Race and Ethnicity unknown	1.18	392	69.5%	1.23	172	30.5%	1.19	564
Two or more races	1.01	268	72.0%	0.99	104	28.0%	1.00	372
White	1.03	5,014	78.9%	1.16	1,341	21.1%	1.06	6,355
Gender								
Female	1.05	3,352	81.2%	1.20	776	18.8%	1.08	4,128
Male	1.05	3,015	73.7%	1.15	1,077	26.3%	1.08	4,092
Age at Entry								
19 and under	1.04	6,198	77.7%	1.18	1,778	22.3%	1.07	7,976
20-24	1.27	152	70.0%	0.97	65	30.0%	1.18	217
25+	1.76	17	63.0%	1.50	10	37.0%	1.67	27
First Generation								
First Generation	1.12	1,351	69.6%	1.24	590	30.4%	1.16	1,941
Not First Generation	1.03	5,016	79.9%	1.14	1,263	20.1%	1.06	6,279
Tuition Residency								
In-State	1.04	3,405	79.5%	1.18	878	20.5%	1.07	4,283
Out-of-State	1.07	2,962	75.2%	1.17	975	24.8%	1.09	3,937
Grand Total	1.05	6,367	77.5%	1.17	1,853	22.5%	1.08	8,220

(79.5%). Again, for out-of-state students, the students who did not retain (1.17) had a higher average number of high-risk courses than those who retained (1.07).

RQ2: Is there a statistically significant association between high-risk course and fall-to-fall retention?

A descriptive analysis was conducted to compare the retention rates by the total number of high-risk courses taken in the first year. Table 5 shows that the students who took 3 or more high-risk courses had the lowest fall-to-fall retention rate (72.2%). The students who took 1 or 2 high-risk courses had a higher retention rates. The students who did not take any high-risk courses had the highest retention rate (79.4%).

Table 5

Comparison of Retention Rates by Total Number of High-Risk Courses Taken in First Year

# risk courses	Retained after 1 Year		Not Retained after 1 Year		Total
	#	%	#	%	#
0	2,087	79.4%	543	20.6%	2,630
1	2,503	77.5%	728	22.5%	3,231
2	1,258	76.7%	382	23.3%	1,640
3+	519	72.2%	200	27.8%	719
Grand Total	6,367	77.5%	1,853	22.5%	8,220

To address both RQ2 and RQ3, a correlation matrix was computed to examine the intercorrelations (i.e., bivariate/one-to-one correlation) of fall-to-fall retention and all the 13 selected independent variables of student characteristics including the total number of high-risk courses taken in the first year. Table 6 shows that all 13 selected independent variables were significantly correlated with fall-to-fall retention.

The total number of high-risk courses taken in the first year (risk total Y1) had a negative correlation with fall-to-fall retention ($r = -0.05$, $p < .001$), but the effect size was very small according to Cohen (1988). Cumulative GPA (1st semester) had the strongest positive correlation with fall-to-fall retention, $r = 0.48$, $p < .001$, which is considered a moderate-large effect size (Cohen, 1988). This means that students who had relatively high cumulative GPAs were more likely to retain after 1 year at UW. The total number of *any* courses taken in the first year ($r = 0.39$, $p < .001$) and high school GPA ($r = 0.30$, $p < .001$) also had moderate positive correlations with fall-to-fall retention.

The relationships between fall-to-fall retention and the total number of high-risk courses taken in the first year, the total number of *any* courses taken in the first year, cumulative GPA, and high school GPA were visualized using logistic regression curve plots (Figure 1). Figure 1 shows that students who take 0 to 2 high-risk courses tend to have a 75% or higher probability to retain; when students take more than 3 high-risk courses, the probability of retaining decreased (Plot A). Students who take more than 8 courses in the first year tend to have a 75% or higher probability of retaining; when students take 10 or more courses, the probability of retaining can be 87% or higher (Plot B). Students who have a cumulative GPA higher than 2.3 tend to have a 75% or higher probability to retain (Plot C). Students who have a high school GPA higher than 3.4 tend to have a 75% or higher probability to retain (Plot D).

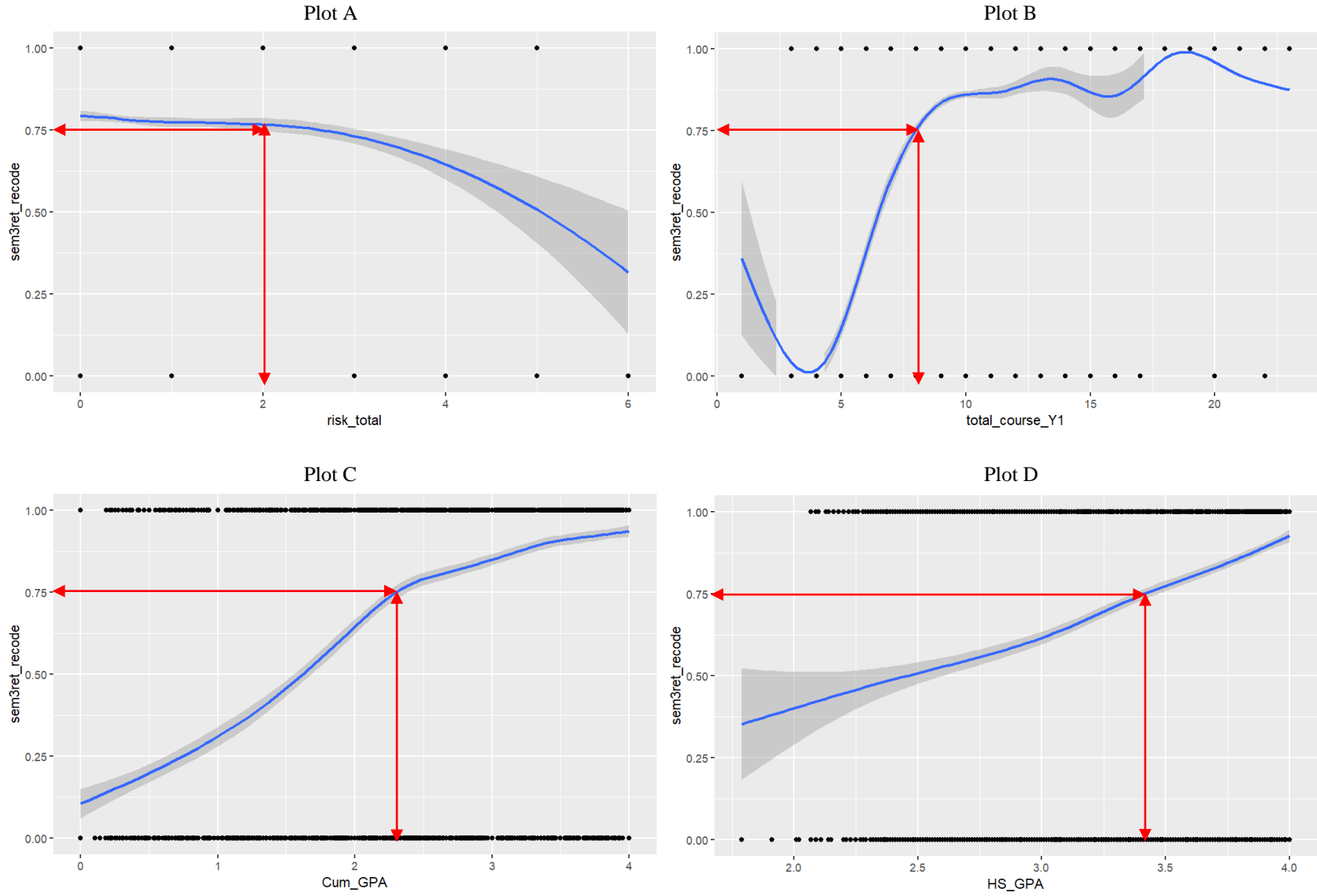
Table 6

Intercorrelations for the Student Characteristics Variables and Fall-to-Fall Retention

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Retained after one year	Gender	Age	Race/Ethnicity	First Generation	Tuition Residency	HS GPA	ACT SAT	Student Classification	Undeclared Major	Cum GPA (1 st semester)	On-Campus	total courses Y1	risk total Y1
1	Retained after one year	1													
2	Gender	-0.09***	1												
3	Age	-0.04***	0.12***	1											
4	Race/Ethnicity	0.05***	-0.03*	0.02	1										
5	First Generation	-0.11***	-0.02*	0.03*	-0.12***	1									
6	Tuition Residency	0.05***	-0.02*	0.06***	0.03*	0.11***	1								
7	HS GPA	0.30***	-0.22***	-0.09***	0.16***	-0.11***	0.18***	1							
8	ACT SAT	0.18***	0.01	-0.05***	0.15***	-0.18***	0.05***	0.50***	1						
9	Student Classification	0.07***	-0.06***	-0.01	0.03*	-0.03**	0.06***	0.21***	0.23***	1					
10	Undeclared Major	-0.03**	-0.06***	0.01	-0.02	-0.02	0.05***	-0.08***	-0.09***	-0.03**	1				
11	Cum GPA (1 st semester)	0.48***	-0.18***	0.01	0.10***	-0.14***	0.01	0.56***	0.39***	0.15***	-0.04***	1			
12	On-Campus	0.02*	-0.01	0.01	0.00	0.01	-0.00	-0.02	0.00	0.01	-0.03**	-0.01	1		
13	total courses Y1	0.39***	-0.08***	-0.06***	-0.02	-0.04**	-0.02	0.13***	0.09***	0.04***	-0.02	0.30***	0.04**	1	
14	risk total Y1	-0.05***	0.00	0.04***	-0.04**	0.04***	-0.01	-0.21***	-0.27***	-0.16***	0.05***	-0.25***	0.02	0.02	1

Notes: * $p < .05$ ** $p < .01$ *** $p < .001$ Correlation effect size: small $r = 0.10$, moderate $r = 0.30$, large $r = 0.50$ (Cohen, 1988)

Figure 1
Logistic Regression Curve Plots for Fall-to-Fall Retention



RQ3: Considering the other student characteristics, what is the best model (a combination of predictors) to predict first-time, full-time students' fall-to-fall retention?

Logistic regression was conducted to investigate the best model using the selected 13 predictor variables to predict whether a first-time, full-time student retained after one year at UW.

All 13 predictor variables were entered as independent variables in the base model, and fall-to-fall retention was entered as the dependent variable. The base model was run with the binomial logistic regression analysis in R. The base model was then simplified by removing the non-significant variables. Two methods for the model simplification were used and the results were compared: (a) Only one variable with the largest p -value ($\geq .05$) was deleted in each step, and the revised model was rerun until all variables were statistically significant ($p < .05$); (b) If $p \geq .05$, the variable with the smallest log odds value (estimate) was deleted, and the revised model was rerun until all variables were statistically significant ($p < .05$). The results showed that the final models were the same after using both methods.

Table 7 presents the results of the logistic regression model predicting fall-to-fall retention of first-time, full-time students. When all 7 predictor variables are considered together, they significantly predict whether a student is retained after one year at UW. The results suggest that the odds of fall-to-fall retention are increasingly greater as cumulative GPA (1st semester), High School GPA, tuition residency, and the number of total courses in first year increase. However, the odds of retention are decreasing for students who are first-generation and those with an undeclared major.

It is noticeable that the number of high-risk courses in the first year (risk total Y1) had a positive logistic regression coefficient in the logistic model (estimate = 0.07), but it had a negative correlation coefficient with fall-to-fall retention in the correlation matrix ($r = -0.05$). This might be because "the original relationship between the two variables is so close to zero that the difference in the signs simply reflects random variation around zero" (Falk & Miller, 1992, pp. 75-76).

Table 7

Significant Predictors of First-Year, Full-Time Students' Fall-to-Fall Retention

Predictor	Estimate	Std. Error	z value	Pr ($> z $)
(Intercept)	-6.60	0.33	-19.92	<0.001
First Gen	-0.33	0.07	-4.47	<0.001
Tuition Residency	0.43	0.07	6.25	<0.001
HS GPA	0.43	0.09	4.91	<0.001
Undeclared Major	-0.23	0.12	-1.98	0.048
Cum GPA (1st semester)	0.99	0.04	23.63	<0.001
total courses Y1	0.40	0.02	21.15	<0.001
risk total Y1	0.07	0.03	2.13	0.033

Conclusion

This research report examined the relationship between high-risk courses of fall-to-fall retention of the first-time, full-time students at the University of Wyoming. The findings indicate that students who did not retain after 1 year took more high-risk courses than those who retained on average. When compared the demographic information of the students who took the high-risk courses, American Indian or Alaska Native students had the highest average number of high-risk courses in their first year and the lowest retention rate among all race/ethnicity groups; and students of age 25+ had the highest average number of high-risk courses and the lowest retention rate compared to all other age groups. Considering

the other student characteristics, the significant predictors of fall-to-fall retention of the first-time, full-time students include: cumulative GPA of the first semester, high school GPA, tuition residency, total number of courses taken in the first year, first generation, undeclared major, and the number of high-risk courses taken in the first year. Some practical recommendations for improving student success in the high-risk courses and their retention rate are discussed below:

1. Academic advising: Considering student characteristics needs to be part of advising whether first-time students should take high risk courses in the first year. Factors such as ethnicity, age, tuition residency, high school GPA, first generation status, and undeclared majors should be balanced against the number and type of high-risk courses that students are advised to take their first year.
2. Tutoring: Collaborating with the tutoring center on the identified high-risk courses, especially in STEM majors, to ensure tutoring resources are available.
3. Career/major advising: Offering support and resources for the undeclared students to determine when and which high-risk core courses they should take.

At UW, the implementation of the Navigate's predictive analysis should help with this, but further work with advisors to consider specific factors could enhance advising. Comparing the inputs to the Navigate model with those found in this paper is an important step to understanding and validating Navigate's predictive modeling.

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