Identifying At-Risk Students to Raise Retention and Revenues

http://www.unr.edu/ia/research

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Two Institutions, One Mission
Challenges for Institutional Research

- Compliance vs. Self-Improvement
- Developing a culture of evidence
- From reporting to analysis
- Converting results into ‘actionable’ statements
- From ‘data silos’ to integrated warehouse
- Leverage technology, stay abreast of tech
- Follow highest standards, best practices
- Know your customers, mission
- Empower staff, continuous honing of skills

The Institutional Context

- Student success: a strategic imperative
- Performance-based state funding impending
- Dwindling state support for higher education
- Tuition-revenue maximization
- Reputation and marketing
- Effective senior-management support by IR
- K-16 Education Collaborative
  - High school transcript study
  - High school gateway curriculum
  - Reversing the tide of college remediation
### The Institutional Context

#### Total Enrollment

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>17,679</td>
<td>18,004</td>
<td>18,227</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>13,660</td>
<td>14,415</td>
<td>14,675</td>
</tr>
<tr>
<td>Graduate</td>
<td>3,248</td>
<td>2,935</td>
<td>2,894</td>
</tr>
<tr>
<td>First-Professional (Medical School)</td>
<td>246</td>
<td>249</td>
<td>251</td>
</tr>
<tr>
<td>Non-Degree</td>
<td>525</td>
<td>405</td>
<td>407</td>
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</table>

#### Ethnicity

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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</thead>
<tbody>
<tr>
<td>American Indian/Alaskan</td>
<td>173</td>
<td>156</td>
<td>152</td>
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<tr>
<td>Asian American</td>
<td>1,142</td>
<td>1,053</td>
<td>1,148</td>
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<tr>
<td>Black, Non-Hispanic</td>
<td>469</td>
<td>557</td>
<td>610</td>
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<tr>
<td>Hispanic</td>
<td>1,911</td>
<td>2,032</td>
<td>2,419</td>
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<tr>
<td>Multi-Ethnic</td>
<td>534</td>
<td>872</td>
<td>942</td>
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<tr>
<td>Pacific Islander</td>
<td>127</td>
<td>41</td>
<td>68</td>
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<tr>
<td>White, Non-Hispanic</td>
<td>12,583</td>
<td>12,329</td>
<td>12,150</td>
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<tr>
<td>Non-Resident Alien</td>
<td>554</td>
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<td>512</td>
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<tr>
<td>Unknown/Unspecified</td>
<td>186</td>
<td>370</td>
<td>226</td>
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</table>

#### New Freshmen Enrollment

![Graph showing new freshmen enrollment from 2008 Fall to 2012 Fall]

- Total: 2,296, 2,764, 2,880, 2,780
- Out of State: 366, 599, 835, 2,724
- Nevada residents: 1,930, 2,172, 2,445, 2,056
The Institutional Context

All Revenue Sources vs General Fund

Key Operational Indicators

Student Success

MEASURING SUCCESS
University of Nevada, Reno

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<th>Baseline</th>
<th>Current</th>
<th>Goal</th>
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<tr>
<td>Grow Student Enrollment</td>
<td>Fall 07</td>
<td>Fall 09</td>
<td>Fall 12</td>
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<tr>
<td>Undergraduate enrollment</td>
<td>13,205</td>
<td>13,327</td>
<td>15,705</td>
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<tr>
<td>Graduate enrollment (incl. MDs)</td>
<td>3,476</td>
<td>3,535</td>
<td>4,101</td>
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<tr>
<td>Diversity of undergraduates/graduates</td>
<td>19%/12%</td>
<td>21%/12%</td>
<td>25%/17%</td>
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<tr>
<td>Improve Retention Rates (first-time, full-time freshmen)</td>
<td>Fall 05 cohort</td>
<td>Fall 09 cohort</td>
<td>Fall 10 cohort</td>
</tr>
<tr>
<td>First year retention</td>
<td>77%</td>
<td>80%</td>
<td>85%</td>
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<tr>
<td>Second year retention</td>
<td>83%</td>
<td>83%</td>
<td>90%</td>
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<tr>
<td>Foster Culture of Completion</td>
<td>Fall 01 cohort</td>
<td>Fall 04 cohort</td>
<td>Fall 07 cohort</td>
</tr>
<tr>
<td>New freshmen 6-year graduation rate</td>
<td>48%</td>
<td>50%</td>
<td>60%</td>
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<tr>
<td>Average years to graduation of new freshmen</td>
<td>4.7</td>
<td>4.7</td>
<td>4.5</td>
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<tr>
<td>% of grad students completing degree within 7 yrs</td>
<td>75%</td>
<td>76%</td>
<td>90%</td>
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</tbody>
</table>
Examples of Actionable Findings

- Study abroad enhances academic performance
- Impact of classroom facilities/schedule on learning
  - Smaller rooms are preferable
  - After-2pm courses associated with lower performance
- Student financial aid to maximize retention
  - Tuition discounts for middle-income students
  - More academic support for low-income students
  - [http://www.uark.edu/ua/der/EWPA/Research/School_Finance/1802.html](http://www.uark.edu/ua/der/EWPA/Research/School_Finance/1802.html)
- Effect of high school environment on freshmen success
  - [http://www.uark.edu/ua/der/EWPA/Research/Achievement/1808.html](http://www.uark.edu/ua/der/EWPA/Research/Achievement/1808.html)

In Need of Math Remediation* at UNR

<table>
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<th>High School Senior Year Math</th>
<th>Percent</th>
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<tr>
<td>Calculus</td>
<td>41</td>
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<tr>
<td>Pre-Calc, Trig</td>
<td>495</td>
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<tr>
<td>Stats, Pre-IB</td>
<td>408</td>
</tr>
<tr>
<td>Algebra 4(8)</td>
<td>982</td>
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<tr>
<td>Lower math</td>
<td>218</td>
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*ACT math < 21 or SAT math < 500
First-Year Momentum* at UNR by AP Intensity

Number of AP Subjects in High School

*100-pt index of first-year GPA and completed credits

Relative First-Semester Success by High School Origin

Note: Excluding schools with < 20 students; *SAT scores converted to ACT scale
Raising Graduation Rates
Comparing 4-year and 6-year-plus Graduates

Opportunity cost of staying one more year in college = $32,000 in foregone earnings plus annual increase in tuition cost.

- Final GPA: 3.4 vs. 2.9
- Change in Major: 25% vs 55%
- Internship: 31% vs 24%
- Difference in avg semester load: 3 credits
- CoreHum 201 Grade: 3.3 vs 2.6
- MathGPA: 3.12 vs 2.4
- Honors Courses: 14% vs 5%
- First-Y GPA: 3.35 vs 2.71
- HS GPA: 3.5 vs 3.2
- ACT: 24.5 vs 22.2
- Capstone GPA: 3.5 vs 3.2
- Avg annual remaining need: $2,610 vs $3,270
- Difference in avg semester load: 3 credits


Relevant Previous Research

At-Risk Forecasting Model

- Identify at-risk freshmen students after initial matriculation for *early* intervention program
- Develop coefficients for predictors determining student fall-to-spring/fall dropout risk
  - Logistic regression model using historical cohorts as training dataset
  - Maximize prediction accuracy with balanced dataset
- Dropout risk scoring for new freshmen
  - Transformation of the logit(p) into probability scores
  - Decile grouping of scored students
  - Compare deciles with actual enrollment and other predicted enrollment (MAP-Works: [http://www.unr.edu/mapworks](http://www.unr.edu/mapworks))
- Reporting of dropout risk via secure online access

Data Description

- Data sources
  - Matriculation system (SIS legacy, Peoplesoft, DW)
  - MAP-Works
- Student cohorts
  - New full-time freshmen (excl. foreign students)
  - Fall entry ‘02-’09 for model dev. (training set, N=17,311)
  - Fall entry 2010 for model validation (holdout set, N=2,527)
- Data elements at start of first semester
  - Student demographics (age, gender, ethn/race, residency)
  - Academic preparation (high school GPA/test score index)
  - Financial aid profile (unmet need, Pell, loans, scholarships)
  - Credits enrolled, campus housing (y/n), athlete (y/n)
- Data elements after start of first semester
  - MAP-Works survey risk scores (Sep., Nov., Feb)
Data Management Tasks

• Exploratory data analysis
  – Variable selection (bivariate regression on outcome variable)
  – Variable coding (continuous/categorical/dummy in logit model)
  – Missing data imputation, constant-$ conversion (fin. aid data)
  – Composite variable(s)
    • Acad prep index = (HSGPA*12.5)+(ACTM*.69)+(ACTE*.69)
  – Variables excluded: college remediation, ACT/SAT test date

• Logistic regression model
  – Maximize model fit (-2LL test/score, pseudo R², HL sig.)
  – Create balanced sample in training dataset to optimize correct classification rate (CCR) for enrollees vs. non-enrollees (i.e. model sensitivity vs. specificity): all non-enrollees plus random sample of enrollees of ~ equal N)

Predicting Student Success

Data Management Tasks

• Scoring of relative dropout/retention risk

\[ p = \frac{\exp(a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 \ldots)}{1 + \exp(a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 \ldots)} \]

Where:
- \( p \) = probability of enrollment/non-enrollment
- \( \exp \) = base of natural logarithms (~ 2.72)
- \( a \) = constant/intercept of the equation
- \( b \) = coefficient of predictors (parameter estimates)

Approximation of \( p \):

\[ (p\{1-p\}*b) \]

Where:
- \( p \) = baseline probability of dependent variable
- \( b \) = logit coefficient
Selected Factors and Spring Retention
Fall Cohorts 2002-09 (N=17,311)

Retention Rate

Selected Factors and 2nd Fall Retention
Spring-Retained Fall Cohorts 2002-09 (N=15,570)
Data Analysis

### Predicting Student Success

#### Model tries to maximize correct prediction of at-risk students (non-enrollees), so they can be focused on, without raising the chance of selecting non-risk students (i.e. beyond OR = 1 or CCR = 0.5).

#### Balanced Model Classification Rates*

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<tr>
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<th>Observed</th>
<th>Predicted</th>
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<tbody>
<tr>
<td></td>
<td>Spring Retention</td>
<td>No</td>
</tr>
<tr>
<td>Spring Retention</td>
<td>No</td>
<td>1122</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>673</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td></td>
<td>64.0</td>
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</table>

*a. The cut value is .55; HL sig. = .364; Nagelkerke R-sq = .161*

#### Balanced Model Parameter Estimates

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<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.*</th>
<th>Exp(B)</th>
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<td>Age</td>
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<td>.033</td>
<td>1.294</td>
<td>1</td>
<td>.255</td>
<td>.963</td>
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<tr>
<td>Asian</td>
<td>.335</td>
<td>.161</td>
<td>4.305</td>
<td>1</td>
<td>.038</td>
<td>1.397</td>
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<tr>
<td>Credits</td>
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<td>.026</td>
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<td>.000</td>
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<td>.000</td>
<td>1.815</td>
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<td>.000</td>
<td>2.256</td>
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<tr>
<td>OnCampFlag</td>
<td>.596</td>
<td>.096</td>
<td>38.738</td>
<td>1</td>
<td>.000</td>
<td>1.814</td>
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<tr>
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<td>.006</td>
<td>6.350</td>
<td>1</td>
<td>.012</td>
<td>.985</td>
</tr>
<tr>
<td>Constant</td>
<td>-.599</td>
<td>.803</td>
<td>48.632</td>
<td>1</td>
<td>.000</td>
<td>.004</td>
</tr>
</tbody>
</table>

*a. Single-step variable entry*
Data Analysis

Predicted Retention Decile
Spring Status of Fall 2010 Cohort

Actual Retained Departed

1 71 24 33
2 48 33 20
3 33 20 18
4 20 18 18
5 18 18 13
6 18 13 15
7 10 10 10
8 10 10 10
9 10 10 10
10 10 10 10

MAP-Works Risk Assessment, Fall 2010 Cohort

Actual Spring Retention

Overall* Sept Survey Nov Survey Feb Survey*

Low Moderate High Non-Participant

*Assesses fall 2011 dropout risk of spring-retained
Gauging Survey Value

Predictors | Baseline | MW Sep Survey | MW Nov Survey | MW Sep Survey | MW Nov Survey | MW Nov Survey |
---|---|---|---|---|---|---|
Age | 2.1 | * | 2.4 | * | 2.2 | * |
Asian | 0.5 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 |
Credits Enrolled | 5.5 | *** | 6.1 | *** | 6.1 | *** |
ClarkRural | 13.6 | *** | 14.4 | *** | 14.4 | *** |
LoanFlag | 1.4 | * | 0.7 | * | 0.5 | * |
PellFlag | 1.3 | * | 1.9 | * | 1.9 | * |
MillFlag | 13.9 | *** | 17.1 | *** | 17.1 | *** |
AthleteFlag | 0.0 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 |
HSGFlag | 15.9 | *** | 13.5 | *** | 13.5 | *** |
AcadIndex | 7.1 | *** | 0.9 | *** | 0.9 | *** |
RemNeedFlag | 2.4 | * | 2.8 | ** | 2.8 | ** |
MWR HI | 9.9 | *** | 23.5 | *** | 23.5 | *** |
MWR MO | 4.1 | *** | 11.1 | *** | 11.1 | *** |
LR test pass | yes | yes | yes | yes | yes | yes |
Nagelkerke R² | 0.19 | 0.21 | 0.25 | 0.21 | 0.25 | 0.25 |
CCR of At-Risk | 76.0% | 75.6% | 78.0% | 75.6% | 78.0% | 78.0% |

Predicting Student Success

A sustained 2% point rise in prediction accuracy over 5 years due to MAP-Works may translate into:
- $237,500 in additional net revenue (5x1900x5x5) per cohort
- Assuming no freshmen enrollment growth

But...

Five-year cost of survey implementation
- Product cost/fee, on-campus HR/IT investment

Data not available until late in the semester!

Balanced model (2002-10 data) yields 79% CCR for at-risk students, i.e. better than survey prediction

Survey prediction furnishes no at-risk deciles
Value of Student Self-Reported Data for At-Risk Prediction

- **Sources:**
  - On-campus surveys
  - ACT Student Profile Q
  - SAT Student Descriptive Q
  - NSSE, CIRP (HERI-UCLA)

- **Limitations:**
  - Validity of acad exp questions
  - Convergent validity of construct
  - Cognitive vs. affective questions
  - Interpretive ambiguity
  - Mental recall
  - Vague quantifiers

Improving the Bottom Line

- **Rise in freshmen retention by 4 percentage points due to better at-risk forecasting**
  - AY 2010-11 *additional net tuition revenues* = $215,119 (for 94 NV, 19 WUE, excl OS students) for one cohort in one year, without OS $!
  - Downstream *cumulative additional net tuition revenues* result in $ millions!

- **How do we know? Pre/post advising records of students with comparable risk scores**

- **Incentive for student to speed up graduation**
  - Opportunity cost per year in foregone earnings = $32,000 per year (published constant 2010-$)
## Sample Data for Advisors

* http://www.unr.edu/ia

### Dropout Risk Decile Relative (10=highest; 1=lowest) Spring Retention %tile

<table>
<thead>
<tr>
<th>R Number</th>
<th>Last Name</th>
<th>First Name</th>
<th>Email Addr</th>
<th>Age</th>
<th>College</th>
<th>Dept</th>
<th>Major</th>
<th>Dropout</th>
<th>Risk Decile</th>
<th>Relative Spring Retention %tile</th>
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</thead>
<tbody>
<tr>
<td>18LBA</td>
<td>ART</td>
<td>BA-AHI</td>
<td>9</td>
<td>14.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>BA-AN</td>
<td>8</td>
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<td></td>
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<td></td>
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<td>BA-AN</td>
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### Sample Data for Advisors

* http://www.unr.edu/ia

<table>
<thead>
<tr>
<th>Gender</th>
<th>Ethnicity</th>
<th>Credits</th>
<th>Resident State/Cnty</th>
<th>HS GPA</th>
<th>ACTE</th>
<th>ACTM</th>
<th>Has Pell Loan$ (1=yes)</th>
<th>Has Loan$ (1=yes)</th>
<th>Clark Cnty Resi (1=yes)</th>
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<tr>
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</tbody>
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Impact of this At-Risk Forecasting Model

- University Retention Rates Hold Steady As States Balance Access with Success. Scripps Howard Foundation Wire, April 15, 2011.


- Consulting services to IR offices at institutions in Arizona, California, Hawaii, and Texas.

Predictive Analytics at U. of Hawaii

- New freshmen at the University of Hawaiʻi at Mānoa, Hawaiʻi’s flagship public university.
- 78% retention rate. 4 percentage points below peer average. Rate flat for 5 years.
- Excellent data storage, infrastructure, and IR reporting.
- Growing need to convert data results into actionable strategies by establishing predictive analytics.
Predictive Analytics at U. of Hawaii

- Relevant previous research has provided a suitable starting point for developing at-risk student forecasting model.
- Freshmen regression model has been well-received by campus stakeholders.
- Mānoa IR now moving from model building to implementation.
- IR and Advising staff from U. of Nevada-Reno travelled to Mānoa to share insights on implementing predictive analytics.

Takeaway from Collaboration

- Early-alert data key
- Identify results that are actionable.
- Support for student advising, including training on how to use data.
- Involve colleges and departments.
- Ways to increase awareness of retention and graduation rates
  - Campaigns
  - Showing impact on the bottom line
Improving the Bottom Line at the University of Hawaii

• **388** freshmen from 2010 dropped out in year one.
• Retaining **26** students from 2010 would have improved Mānoa's overall retention rate from 78.6% to **80%**.
• Additional Revenue from Tuition and Fees = **$259,920** (for 18 HI, 8 WUE, excludes OS).
• Are there 26 students in this group that we can help/retain?

Progress on Implementation at the University of Hawaii

• Currently doing:
  – Campus road show to share prediction model to stakeholders (including faculty and students).
    - Improved presentation for non-IR audience
  – Collaborating with student employment office
    - Better marketing of on-campus job opportunities to freshmen
  – Integrating data with accreditation reports.
  – Touting ‘odds ratios’ anecdotes in campus campaigns
  – Working more closely with College/Department advising personnel
  – Considering qualitative surveys to supplement quantitative data
  – Clarifying the role of analytics in MIRO’s mission
Barriers to Implementation at the University of Hawaii

- Culture change
- Wary of misuse of data
- More accountability
- Faculty buy-in

Next Steps in Implementation at the University of Hawaii

- Beta-test with selected student advisors in spring fall 2013.
  - At-risk students monitored and called in for advising/intervention support.
- Hiring an undergraduate peer mentor who will serve as an "intervention specialist".
- Risk scores re-visualized in to a dashboard to focus advisors attention to underlying variables and not the risk scores.
- Collaboration with First Year Experience office.
  - Enrolling in the First Year Experience class is a significant predictor in Hawai‘i’s model.
- "De-siloing" of data for improved data access.
- Continued relationship-building at the college level and beyond.
- Continuing to establish analytics with early wins in our IR office.
Summary

- Predicting students at-risk
  - Keep prediction model parsimonious
  - Keep prediction data for student advising intuitive and simple (actionable)
  - Triangulate prediction data with multiple sources of information
  - Use prediction data as component part of student dropout-risk assessment
  - Follow ‘best practices’ in IR and keep abreast of changes in analytical and data reporting tools

- Using prediction data for student advising
  - Embrace the use of available data
  - Ensure users conceptually understand what’s behind the data
  - Use data as a complementary piece of information when advising students
  - Timing can be critical in terms of student intervention as well as maximizing advising resources

- Stay abreast of new research on predictive analytics:

Link to presentation:
http://www.unr.edu/ia/research