Predictive Analytics for Student Success
A Data Sharing Initiative Between Two Community Colleges and an Online University

An Executive Report | Presented by University of Maryland University College
Funded through a grant from the Kresge Foundation
University of Maryland University College (UMUC) is committed to student success. To that end, we are pleased to partner with two community colleges that are the largest sources of transfer students to UMUC: Montgomery College and Prince George’s Community College to predict and improve student success. These partnerships enable UMUC to evaluate student progress toward a degree from the time they enter the community college until they graduate from UMUC. This collaboration was funded by the Kresge Foundation, which supports student success and specifically targets students who are low-income or under-represented minorities.

The intent of the Kresge-funded project was to identify factors in students’ community college academic backgrounds that would be predictive of success after transfer to UMUC and to provide interventions, policy changes, or additional academic resources to improve students’ overall academic performance and persistence.

This partnership has given UMUC the opportunity to assemble and analyze a large-scale collection of data on transfer students. While most transfer students to UMUC are relatively well prepared, those who are not may need additional assistance to overcome academic barriers. UMUC, Montgomery College, and Prince George’s Community College have worked together to develop and implement several interventions in support of student success. We will continue to work together to align curricula in particular academic areas where students need the most help, such as accounting and math.

Additionally, UMUC has developed a success calculator that academic advisors at the community colleges can use to determine what courses students should take at the community college to increase their likelihood of success after transfer. This calculator is unique to UMUC, Montgomery College, and Prince George’s Community College, but can become a model for other institutions to use as well.

We wish to express our thanks to the Kresge Foundation for their support of this research and for providing the opportunity to develop learner analytics models with our partners at the community colleges.

Javier Miyares
President
University of Maryland University College

Marie A. Cini
Provost and Senior Vice President for Academic Affairs
University of Maryland University College

UMUC serves the needs of students with diverse academic backgrounds and is the largest recipient in Maryland of transfer students from community colleges.
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Executive Summary

PROJECT PURPOSE

The Predictive Analytics for Student Success (PASS) project was funded by the Kresge Foundation. The project is a collaborative data-sharing partnership between University of Maryland University College (UMUC) and two Maryland community colleges: Montgomery College (MC) and Prince George’s Community College (PGCC). The purpose of the grant was as follows:

- To develop a multi-institutional database that aggregated and aligned student and course information across institutions. Data included demographics, course-taking behavior, course performance, and online course activity.

- To use predictive modeling and data mining to identify indicators of students’ success at the community colleges and at UMUC.

- To use research to inform the development of interventions aimed at improving outcomes for undergraduate students transferring from the community colleges to UMUC.

KEY FINDINGS

- **Math at the community college**: Variables associated with taking math at the community college were found to be significant predictors of first-term GPA at UMUC, re-enrollment, and graduation.

- **First-term performance**: Students’ performance in the first semester at UMUC was found to be a significant predictor of student re-enrollment and graduation.

- **Online classroom engagement**: Engagement in the online classroom in combination with students’ community college GPA was a significant predictor of successful course completion in students’ first semester at UMUC.
Institutional Profiles

THE KRESGE FOUNDATION

The Kresge Foundation is a private, national foundation, headquartered in metropolitan Detroit, Michigan, that works to expand opportunities in America’s cities through grant-making and investing. Kresge’s broad fields of interest are in seven succinctly defined programs: Arts and Culture; Community Development; Detroit; Education; Environment; Health; and Human Services. Each area has a particular focus with defined long term goals and strategies to guide Kresge’s grant-making and investing. The Kresge Foundation partners with organizations committed to the needs of disadvantaged individuals and communities, including small, mid-size, and large nonprofits as well as with the public and private sectors.

University of Maryland University College

University of Maryland University College is a regionally accredited, four-year, online university and part of the University System of Maryland. UMUC’s mission is to serve working adults by providing open access to career-relevant academic programs. UMUC educates more than 84,000 students each year and is considered a leader in online education. Since 1947, UMUC has been a leading provider of education services to the U.S. military, delivering instruction and student support services on military installations in over 25 countries. Supporting adult students in achieving their goals, UMUC offers more than 95 degrees and certificates in today’s most in-demand fields. UMUC is also committed to diversity: 47% of UMUC students are minorities and survey results indicate that 35% are first generation college students, 78% are working full-time, and 49% are working parents. UMUC receives more transfer students from Montgomery College and Prince George’s Community College than from any other institution.

Prince George's Community College

Prince George’s Community College is the number one choice of Prince George’s County, Maryland residents for an undergraduate education and is a leading institution in training and preparing employees for the county’s workforce. Since 1958, the college has provided students, the county, and the region with high quality and affordable education. As a result, among Prince George’s County high school graduates who go on to college, 50% choose to attend Prince George’s Community College. Prince George’s Community College serves a diverse population of more than 40,000 students with origins in 103 countries around the world. The college offers more than 200 academic, workforce development, and continuing education programs of study and provides transfer scholarships for students continuing their education at four-year colleges and universities.

Montgomery College

Montgomery College’s first classes were held in the evenings at a local high school, starting in 1946. Today, Montgomery College serves nearly 60,000 students a year as they pursue a wide variety of educational goals in more than 100 areas of study. Montgomery College has three campuses in Maryland: Germantown, Rockville, Takoma Park/Silver Spring, and the Workforce Development and Continuing Education Centers in Gaithersburg and Wheaton. Its largest campus, Rockville, serves more than 15,000 full-time and part-time students, by offering more than 600 courses in over 40 areas of study. The college facilities include a Cultural Arts Center, with a 500-seat theater and dance studio, and a newly dedicated Bioscience Education Center that will be the cornerstone of a future Life Sciences Park to support study in biotechnology and life sciences.
In 2010, University of Maryland University College secured funding from the Kresge Foundation for a project designed to better understand predictive factors associated with student retention and completion. Since UMUC serves the needs of students with diverse academic backgrounds and is the largest recipient in Maryland of transfer students from community colleges, UMUC was interested in entering into data-sharing partnerships with local community colleges to understand students' educational experiences prior to transfer and to better meet the needs of these students. In addition, UMUC was interested in using learner analytics and data mining techniques to make sense of the big data it had available on students' learning in online environments and to use these data in predicting student success so that interventions could be developed to assist students in need of support.

Montgomery College and Prince George's Community College were interested in collaborating with UMUC on the Predictive Analytics for Student Success (PASS) Project because UMUC is the most frequently selected transfer destination for their students. MC and PGCC were interested in understanding what factors enabled their students to be prepared to transition to a four-year institution and to be successful in meeting their educational goals.

The purpose of the Predictive Analytics for Student Success Project was as follows:

- To aggregate data on student course taking behaviors at the community college and at UMUC and to build an integrated database to house these data.
- To use predictive modeling and data mining to identify indicators of students' success at the community colleges and at UMUC.
- To identify factors predictive of student success at UMUC in order to inform the development of interventions aimed at improving outcomes for undergraduate students transferring from community colleges to UMUC.

A full report describing data development, predictive modeling, data mining, and intervention implementation and evaluation is available. Contact ir@umuc.edu for a copy.
Data

DATA SHARING ACROSS INSTITUTIONS

A Memorandum of Understanding (MOU) was negotiated and signed between UMUC and MC and PGCC in order to ensure data security and establish parameters for data use. The MOU allows the UMUC project team to conduct research using individual student data while protecting student information and confidentiality.

THE STUDENT POPULATION

The population of students targeted for these analyses included undergraduate students enrolled at UMUC for any portion of time between Spring 2005 and Spring 2011. Of these, over 20,000 students were identified as also having attended MC or PGCC prior to transferring to UMUC.

Students in the population were, on average, 29 years old and predominantly female (58%). About 24% of students self-identified as White and 65% as Minorities, with 14% of students not specifying a race/ethnicity.

A subset of the population, 8,058 transfer students to UMUC from MC and PGCC, was used for predictive modeling. These students enrolled in their first semester at UMUC between 2005 and 2011 and were pursuing a first-time bachelor’s degree.

For this research, over 300,000 course records were collected and aligned across institutions. A total of 493 source and derived variables were analyzed for inclusion in the dataset. Over 300 variables were tested as part of data mining analyses. Forty key variables were examined in predictive modeling.
DATA INTEGRATION

An integrated database, the Kresge Data Mart (KDM) (see figure 1), was developed to house data about students who transferred from MC and PGCC to UMUC. Student demographics, course taking behaviors, and performance data at the community college were provided by MC and PGCC. In addition, data about advising and student activity in the online classroom at UMUC were added to the database. A diagram of the data sources used to build the KDM is presented.

MEASURES OF SUCCESS

The following student success measures were defined and aligned across institutions:

Successful First Term GPA—Average of all course grades received in the first semester of enrollment at UMUC that is 2.0 or above, on a 4-point scale

Re-enrollment—Enrollment in the immediate next semester after first enrollment at UMUC

Retention—Re-enrollment at UMUC within 12 months after initial enrollment

Graduation—Earning a first bachelor’s degree within eight years of starting at UMUC

Successful Course Completion—The number of courses in which a student received a grade of C or above divided by the total number of courses a student attempted
Research

TRACKING STUDENTS’ ACADEMIC PROGRESS

Predictive modeling was guided by a path model of students’ academic trajectories from transfer to graduation (see figure 2). Each of the key milestones in students’ academic careers was modeled: (a) earning a successful first term GPA, (b) re-enrollment, (c) retention, and (d) graduation.

FIGURE 2. Model of Academic Progress

PROFILING STUDENT SUCCESS

Data mining was used to identify four Success Profiles of students at UMUC (see figure 3). Profiles of student success were visualized in a two-by-two grid showing possible combinations of an earned first term GPA above or below a 2.0 and retention or attrition within a 12-month period. Students falling into the four cells of the grid are characterized as Stars, Strivers, Slipers, and Splitters.

FIGURE 3. UMUC Success Quadrants

- **Strivers (17%)**
  - Despite earning low grades, Strivers return to UMUC.

- **Stars (59%)**
  - Stars do well academically and re-enroll.

- **Slippers (15%)**
  - Slippers earn low grades and don’t persist.

- **Splitters (9%)**
  - Even though they do well academically, Splitters don’t stay at UMUC.

GPA <2.0

GPA ≥2.0
PREDICTING FIRST TERM GPA

Based on the Student Success Profiles identified, the project team developed a model predicting the likelihood of students earning a successful GPA of 2.0 or above in their first term at UMUC. The model used demographic data, community college course taking behaviors, and summative measures of community college experience as predictors. As such, first term success at UMUC was able to be predicted based on data available prior to the start of students' first semester.

The logistic regression model correctly classified 77% of students. All variables presented were significant predictors of earning a successful first-term GPA at UMUC (see figure 4).

FIGURE 4. First Term GPA Predictive Model

76% of community college transfer students earn a successful first term GPA at UMUC.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Community College Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Gender</td>
<td>· Successful Course Completion</td>
</tr>
<tr>
<td>· Age</td>
<td>· Successful Math Completion</td>
</tr>
<tr>
<td>· Minority Status</td>
<td>· Successful English Completion</td>
</tr>
<tr>
<td>· Marital Status</td>
<td>· CC GPA</td>
</tr>
<tr>
<td></td>
<td>· Received an AA at CC</td>
</tr>
</tbody>
</table>
PREDICTING RE-ENROLLMENT

Logistic regression was performed using demographic data, community college course taking behaviors, summative measures of community college experience, and UMUC first term indicators to predict re-enrollment.

The model correctly classified 72% of students. All variables presented were significant predictors of re-enrollment (see figure 5).

FIGURE 5. Re-enrollment Predictive Model

66% of community college transfer students re-enroll at UMUC and 78% of students are retained within a 12-month period.
GRADUATION RATES

The eight-year graduation rate for students who transferred from MC and PGCC to UMUC was tracked by fiscal year to Spring 2014. Graduation rates at one to eight years after enrollment at UMUC are shown for each fiscal year cohort (see table 1).

The eight-year graduation rate for students entering UMUC in fiscal year 2006 was 49%.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>N</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
<th>YEAR 6</th>
<th>YEAR 7</th>
<th>YEAR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2006</td>
<td>1017</td>
<td>6%</td>
<td>21%</td>
<td>30%</td>
<td>37%</td>
<td>42%</td>
<td>45%</td>
<td>47%</td>
<td>49%</td>
</tr>
<tr>
<td>FY 2007</td>
<td>1164</td>
<td>5%</td>
<td>16%</td>
<td>25%</td>
<td>31%</td>
<td>38%</td>
<td>41%</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>FY 2008</td>
<td>1138</td>
<td>4%</td>
<td>18%</td>
<td>28%</td>
<td>34%</td>
<td>38%</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2009</td>
<td>1212</td>
<td>7%</td>
<td>20%</td>
<td>31%</td>
<td>38%</td>
<td>42%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2010</td>
<td>1333</td>
<td>6%</td>
<td>20%</td>
<td>31%</td>
<td>36%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2011</td>
<td>1300</td>
<td>7%</td>
<td>22%</td>
<td>32%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2012</td>
<td>780</td>
<td>10%</td>
<td></td>
<td>24%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PREDICTING GRADUATION

A model predicting graduation within eight years after first enrollment at UMUC used demographic data, community college course taking behaviors, summative measures of community college experience, and UMUC first term indicators. The predictive model was based on MC and PGCC transfer students enrolling at UMUC between Spring 2005 and Spring 2006. This student sub-sample had eight years of enrollment at UMUC to reach graduation.

The logistic regression model correctly classified 70% of students. All variables presented were significant predictors of eight-year graduation (see figure 6).
STUDENT ENGAGEMENT IN THE ONLINE CLASSROOM

Student engagement was measured by the amount of activity logged for each student in the online classroom. Student engagement was standardized based on the median amount of activity logged for all students. Student activities included entering the classroom, launching a conference, reading a conference note, and creating a response note. Data mining techniques were used to examine student engagement in the UMUC online classroom and course completion at UMUC. Across all enrollments in all courses, students completed 85% of their courses successfully, with a grade of C or above.

- Students demonstrating higher levels of online classroom engagement earned higher grades in their courses.

FIGURE 7. Level of Student Engagement by Grade

Across various algorithms employed in modeling, (e.g., bootstrap forest, boosted tree, neural net), students’ online classroom engagement was predictive of successful course completion at UMUC (see figure 7). Models performed best when students’ community college GPA was included, indicating that academic background and online classroom engagement are key indicators of course success at UMUC.

- Community college GPA and engagement in the online classroom at UMUC together significantly predicted successful course completion at UMUC.
Students logging into the online classroom at UMUC prior to the first day of class was found to be an important differentiator of performance (see figure 8).

- Students entering the online classroom prior to the first day of class were significantly more likely to successfully complete the class, earning a grade of C or above, as compared to students entering after the first day.

- Students entering the online classroom prior to the first day withdrew at a lower rate than did students entering the online classroom on Day 1 or after.

**FIGURE 8. Performance by Early Entry into the Online Classroom**
The logistic regression model employed in predicting successful first term GPA at UMUC was used to develop a tool, the UMUC Success Calculator. The Calculator was developed as an advising tool for community colleges to use in guiding students to select courses that would improve their probability of success after transfer to UMUC. By manipulating various fields, advisors can help students identify courses and behaviors that can impact their eventual success at UMUC.

In addition, project researchers developed a calculator to predict students’ likelihood of graduation from UMUC within an eight-year period based on demographic characteristics, community college background factors, and UMUC first term data (see figure 9). As an example, a specific student’s information is entered into the calculator and their likelihood of graduation is shown as a percentage.

The UMUC Success Calculators were piloted with MC and PGCC advisors. Advisors were able to enter student information and use the calculators to better advise students on which course taking behaviors to focus on in order to increase their success after transfer.

**FIGURE 9. UMUC Success Calculator**

<table>
<thead>
<tr>
<th>Student Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td>Age At Transfer</td>
<td>25</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Asian</td>
</tr>
<tr>
<td>PELL Grant Recipient</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicting Graduation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Math at CC</td>
<td>No</td>
</tr>
<tr>
<td>Percentage of Courses Withdrewn From</td>
<td>20%</td>
</tr>
<tr>
<td>Received an Associated Degree</td>
<td>Yes</td>
</tr>
<tr>
<td>CC Cum GPA</td>
<td>3.56</td>
</tr>
<tr>
<td>CC Cum Credits Earned</td>
<td>60</td>
</tr>
<tr>
<td>First Term GPA at UMUC</td>
<td>3.5</td>
</tr>
<tr>
<td>UMUC First Term Credits Earned</td>
<td>12</td>
</tr>
</tbody>
</table>

**Probability of Graduating in Eight-Year Period**

Calculate 77%
Interventions

As a result of insights from research findings as well as a review of the published literature, the project team developed several interventions designed to promote student success after transfer to UMUC.

**ACCOUNTING 220 AND ACCOUNTING 221**

In collaboration with the Predictive Analytics Reporting Framework (PAR, www.parframework.org), a Gates Foundation funded project, the PASS Project team identified Accounting 220 and 221 as a course sequence with low course completion rates compared with other UMUC courses. The UMUC faculty teaching Accounting 220 and Accounting 221 developed and implemented an online tutoring intervention for UMUC accounting students. The PASS Project team evaluated the effectiveness of the online tutoring intervention. Students participating in online tutoring had a significantly higher term GPA and a significantly higher rate of successful course completion, when compared to students not participating in online tutoring.

<table>
<thead>
<tr>
<th></th>
<th>TEST Participating in Online Tutoring</th>
<th>CONTROL Not Participating in Online Tutoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term GPA</td>
<td>2.52</td>
<td>2.10</td>
</tr>
<tr>
<td>Successful Course Completion</td>
<td>72%</td>
<td>58%</td>
</tr>
<tr>
<td>Re-Enrollment</td>
<td>78%</td>
<td>72%</td>
</tr>
</tbody>
</table>

**ORIENTATION CHECKLIST**

An Orientation Checklist was developed as an aid for community college students transferring to UMUC to assist them in navigating online resources available from UMUC. For example, students were asked to find their advisor’s contact information and to identify the time and location that math and statistics tutoring was available. Although no significant differences were found, students responding to a survey found the checklist to be a useful tool. One student reported: “It helped me compile information and learn how to use UMUC’s website.” UMUC has developed and launched a broader checklist to help all students prepare for their academic careers at UMUC and for graduation.

<table>
<thead>
<tr>
<th></th>
<th>TEST Received the Checklist</th>
<th>Completed the Checklist</th>
<th>CONTROL Did Not Receive the Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term GPA</td>
<td>2.87</td>
<td>3.00</td>
<td>2.91</td>
</tr>
<tr>
<td>Successful Course Completion</td>
<td>73%</td>
<td>77%</td>
<td>77%</td>
</tr>
<tr>
<td>Re-Enrollment</td>
<td>67%</td>
<td>72%</td>
<td>67%</td>
</tr>
</tbody>
</table>
COLLEGE SUCCESS MENTORING PROGRAM

The College Success Mentoring Program was an eight-week pilot program in which students who had transferred from MC or PGCC to UMUC were paired with a peer mentor—a successful student at UMUC who had also transferred from the same community college. Each week, mentors contacted mentees to provide academic and social support and to help with mentees’ adjustment to UMUC. Although no statistically significant improvements in semester performance were found for mentees, unexpectedly, students serving as mentors had a significantly higher cumulative GPA and a significantly higher rate of successful course completion when compared to a control group of students who were invited to be mentors and elected not to participate.

<table>
<thead>
<tr>
<th>MENTORS</th>
<th>TEST</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA</td>
<td>3.56</td>
<td>3.34</td>
</tr>
<tr>
<td>Successful Course Completion</td>
<td>95%</td>
<td>89%</td>
</tr>
</tbody>
</table>

Students serving as mentors had a significantly higher cumulative GPA and a significantly higher rate of successful course completion when compared to a control group of students who were invited to be mentors and elected not to participate.
JUMPSTART

Jumpstart was developed as a four-week onboarding course for students new to UMUC, designed to support students’ academic planning. Jumpstart was offered to students in Spring 2014 and found to improve successful course completion. In Summer 2014, UMUC ran a pilot experiment to judge the effectiveness of jointly offering the Jumpstart course and mentoring to community college transfer students. Students participating in Jumpstart and in the mentoring program were compared to a control group and to students participating in only one of the programs (i.e., only in Jumpstart or only mentoring). No significant differences in performance were found; however, development of Jumpstart continues at UMUC based on previous evidence of its success.

<table>
<thead>
<tr>
<th></th>
<th>TEST Enrolled in Jumpstart</th>
<th>Completed Jumpstart</th>
<th>CONTROL Did Not Enroll in Jumpstart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term GPA</td>
<td>2.42</td>
<td>3.06</td>
<td>2.69</td>
</tr>
<tr>
<td>Successful Course Completion</td>
<td>61%</td>
<td>89%</td>
<td>74%</td>
</tr>
<tr>
<td>Re-Enrollment</td>
<td>76%</td>
<td>91%</td>
<td>75%</td>
</tr>
</tbody>
</table>

WOMEN’S MENTORING, BOYS TO MEN, TRIO

The Women’s Mentoring, Boys to Men, and TRiO mentoring programs, developed by Montgomery College, provide minority students with comprehensive academic and social support throughout their transfer pathways from high school to MC and ultimately to a four-year institution. MC and UMUC will identify students participating in these programs transferring to UMUC and will track them to evaluate their performance.

DIVERSE MALE STUDENT INITIATIVE

Diverse Male Student Initiative (DMSI) is a two-year program at Prince George’s Community College that provides minority male students with role models and academic and career mentoring. DMSI held a two day summer institute that featured keynote speakers and awarded book and tuition vouchers for early registration to participants with the aim of improving academic planning and persistence. PGCC and UMUC will track and evaluate the success and persistence of students who participated in this program and who transfer to UMUC.
Future Directions

Future directions emerging from the completion of the Predictive Analytics for Student Success Project include the following:

- **Longitudinal analyses**: Effects of students’ participation in interventions were analyzed to determine if the interventions influenced retention or degree completion.

- **Aligning math curricula**: PGCC is interested in facilitating meetings between curriculum designers, program directors, and instructors to better align math curricula across institutions in order to ensure students’ academic preparedness.

- **Aligning accounting curricula**: MC is interested in determining the extent to which Accounting courses at the community colleges are aligned with those at UMUC, and evaluating the academic preparation and performance of Accounting majors transferring to UMUC.

- **Tracking students who completed Developmental Education Modules**: Recently, both MC and PGCC have started offering modularized developmental education. When students who have completed the modularized developmental education sequence transfer to UMUC, the team will be able to evaluate the performance of these students as compared to students who did not complete these new modules.

- **Developing collaborations with additional Maryland community college partners**: UMUC is interested in developing data sharing agreements with additional community colleges among the 16 in Maryland, in order to extend the benefits of research and interventions to more students who transfer to UMUC.

- **Generalizing the Success Calculator**: UMUC can develop the success calculator so that it can be used at other institutions with transfer articulations.
Predictive Analytics for Student Success

Leadership Team

EXECUTIVE PRINCIPLE
INVESTIGATORS
Javier Miyares, President, UMUC
Marie A. Cini, Provost & Senior Vice President for Academic Affairs, UMUC

PROJECT SPONSORS
Marcia Watson, Vice Provost for Academic Affairs, UMUC
Denise Nadasen, Associate Vice Provost, Institutional Research, UMUC

STEERING COMMITTEE
Kathleen Wessman, Montgomery College Representative
W. Allen Richman, Prince Georges Community College Representative
Greg Ogle, Data Development for Prince George’s Community College

Elizabeth Mulherrin, Undergraduate Success Initiatives
Assistant Vice Provost for Student Success, UMUC
Lisa Romano, Community College Partnerships
Associate Vice President, College and University Partnerships, UMUC

James Robertson, Data Mining Program Director, Computer and Information Systems, UMUC
J. B. (Ben) Arbaugh, External Evaluator
Professor of Strategy and Project Management, University of Wisconsin—Oshkosh
Peter Shea, External Evaluator
Associate Provost for Online Learning, University of Albany

UMUC INSTITUTIONAL RESEARCH TEAM
Alexandra List, Research Associate, Institutional Research, UMUC
Patti Pezzuti, Manager, Institutional Data Integration, Institutional Research, UMUC

Shannon Acton, Project Coordinator, Institutional Research, UMUC
Delphia Avent, Executive Coordinator, Institutional Research, UMUC

CONSULTANTS
Herb Edelstein & Janet Millenson, Two Crows Consulting

SPECIAL THANKS TO FORMER TEAM MEMBERS
Andrea Lex, Dean, Planning, Assessment, & Institutional Research, PGCC; Dan McCollum, Senior Research Associate, Institutional Research, UMUC; Grace Denman, Project Manager, UMUC; Cheoleon Lee, Senior Research Associate, UMUC; Stephen Penn, Data Mining Consultant, UMUC; Jing Gao, Senior Research Associate, UMUC; Laura Hyde, Graduate Research Assistant, UMUC; Futoshi Yumoto, Senior Research Associate, UMUC; and Hussein Abdul-Hamid, Associate Vice President, Assessment and Evaluation, UMUC.