November 6, 2008

Legislative Services Agency
Response to RFP
Attention: Ms. Kathleen Hanlon, Senior Research Analyst
State Capitol Building
1007 East Grand Avenue
Des Moines, IA 50319

Dear Ms. Hanlon,

Attached please find 20 copies of ACTs proposal in response to the Request for Proposal (RFP) from the Postsecondary Education Rigor Analysis Committee.

The RFP specifically invited bidders to propose an alternative proposal, and this is what we have chosen to do. Specifically, we are responding to items 2 and 4 that are listed on page 4 of the RFP in the Analysis Specifics section under the Scope of Services requested. These items request an investigation of the success of community college students who transfer to a regent's institution, including those students who enroll in district-to-community college sharing agreement or a concurrent enrollment program, and an investigation of the rigor of community colleges and regent's institution courses.

ACT believes we are well placed to do this work. We are finishing work on a project with the Iowa Community colleges that looked at the success of dual credit students at these colleges. As you can see, this fits in exactly with what the legislature is trying to find out. We have most of the data we need to proceed with this work in house currently. Our plan is to extend the results of this study to students who subsequently matriculate at a Regent's institution.

Although our proposal does not satisfy all of the stated goals of the RFP, we believe that it satisfies the important ones. In particular, we are interested in helping the legislature determine if the education that students receive at an Iowa Community college, whether dual-enrollment or as part of regular college enrollment, prepares them for success at a regent's institution.

Note that our timelines are also longer than those envisioned in the RFP. We feel that the work as stated cannot be carefully done in the time given, particularly as our proposal has a period of time for the collection of data. This needs to be done in cooperation with the colleges involved, and so must be done with their resources in mind. Further, part of our proposal requires that students be tested, and this typically requires the involvement of an institution review board, which can delay matters.

If you need any further information, please contact me. My contact information is

Dr. James Sconing
Statistical Research Department – 62
ACT
500 ACT Drive
Iowa City, IA 52243
Phone 319/337-1709
e-mail: james.sconing@act.org
fax: 319/341-2284

Thank you for considering this proposal

James Sconing, Director
Statistical Research Department
ACT

A Proposal to the Legislative Services Agency in Response to its Request for Proposals: Postsecondary Education Rigor Analysis

Postsecondary Education Rigor Analysis

Technical & Business Proposal

Presented by ACT, Inc.
November 7, 2008

PROPOSAL FOR POSTSECONDARY EDUCATION RIGOR ANALYSIS

In this proposal, ACT responds to the Request for Proposal issued by the Postsecondary Education Rigor Analysis Committee to analyze the rigor of the first two years of coursework offered by the community colleges of Iowa. This proposal details a scope of services required (page 3) and invites the bidder to propose an alternative (page 8). This proposal offers an alternative that serves the overall objective of the committee, and we believe would provide the committee with the information that they are seeking with respect to the rigor of the courses at the two year colleges.

Our alternative has three primary goals. The first is an investigation of the success of students who have attended an Iowa community college in subsequent college work done at one of three regent's institutions. The second is to evaluate the success of students who have taken courses at an Iowa community college while still in high school. The final goal is to investigate the course rigor of college level courses taken at the community colleges, and compare these with similar college courses at the regent's institutions. This proposal will detail each of these studies, explaining the methodology, the analysis, and the types of conclusions that would be possible at the end of the study.

1. Success of Transfer Students

ACT proposes to investigate the success of students transferring from community to four-year colleges, with a particular emphasis on success in subsequent courses at the four-year institution, based on performance in prerequisite courses at the community college. This includes development of a system for evaluating the success of these prerequisite courses in preparing students for future college work.

ACT has already worked with the community colleges in Iowa, and has access to student grades in all courses taken at these colleges over a period of several years. We propose to track these students to identify those who subsequently enroll at one of the three regent's institutions. We can identify the students who have transferred to any of the regent's institution by using the National Student Clearinghouse. This is a database consisting of approximately 85-90% of students currently enrolled in college. All three regent's institutions participate, so it should be possible to track any student who went to an Iowa community college to any of the three regent's institutions. After identifying those students who transferred to a regent's institution, we will work with the regent's institutions to gather the grades of these students in subsequent courses, as well as their overall grade point average (GPA) in their first semester (or first year) at the regent's institution.

Based on this data, student success is modeled with the outcome being grade in a particular course, or overall GPA, and the criterion being level of success in a prior class. For example, success in a calculus 1 class could be modeled as a function of student performance in a college algebra class. In particular, the following equation might be used:

Probability of a grade of B or better in calculus
= f(prior grade in college algebra).

where f(x) is a function. In particular, ACT has used a logistic function in many situations like this. An example of this type of analysis can be found in the paper by Allen and Sconing (2004) included in the appendix of this proposal. In the past, ACT has used a standard of a 50% probability of a B or better as the standard for being "college ready." This is the standard used to set the college readiness benchmarks, and will be the standard that will be used for these analyses. An alternative analysis can be run using ACT score as a covariate, making the model:

Probability of a grade of B or better in calculus
= f(prior grade in college algebra, ACT score).

This adjustment allows for differing levels of college readiness, and is commonly used as a covariate which taps underlying ability.

A comparison to other students at 4-year colleges could also be included in this analysis. For example, it might be possible to compare students who take calculus after taking the college algebra course at the community college to students who take calculus after taking the college algebra course at the regent's college. Again, comparisons are made after adjusting for ACT score and prior grade, so that the equation is now:

Probability of a grade of B or better in calculus
= f(prior grade in college algebra, ACT score, 2/4-year college).

In this instance, the coefficient for the term that identifies whether the student took the course at the community college or the regent's institution gives an indication of whether the course at the two-year school was comparable to the course at the four-year school. This analysis can only be done if grades from students who took the prior course at the regent's institution are available. This is a much more onerous data request for the regent's institution, and so will only be done if such data are available.

A similar set of analyses will be done using GPA as the outcome variable. In these analyses a student's prior GPA will be used as the conditioning variable.

At the conclusion of these analyses, the following questions can be answered:

- Are students who take a course in a community college successful in a subsequent course taken at a regent's institution?

- Is there a specific grade in a community college course that indicates a student will be likely to be successful in subsequent courses taken at a regent's institution?
- If there are two students who have taken the same course, one at a community college, and one at a regent's institution earning the same grade, and these students both take the same subsequent course at the regent's institution, are they equally likely to be successful?

2. Success of Students Enrolled in Dual Credit Courses

ACT proposes to investigate the success rates of students who are concurrently enrolled in high school and college. This includes students who take the courses on the campus of the community college while still enrolled in high school, or students who take the course at the high school and receive college credit. In particular, we want to see if these students are subsequently successful when they enroll in a regent's institution.

This is a particularly timely study. ACT is finishing a study with the Iowa community colleges on just this topic. We already have data from Iowa community colleges, where students who take the courses while still in high school are specifically designated as such. In this analysis, students who take the course while in high school are compared to those who are enrolled in college who are taking the same course. The comparisons are made both for performance in the course itself and performance in a subsequent course/semester. Models similar to those described above were used. A final report on this study will be finished by the end of this calendar year.

ACT would seek to extend these models to students who subsequently enroll in a regent's institution. As a first step, ACT would track those students who were identified as dual-credit students to find those who enrolled in a regent's institution. The National Student Clearinghouse will be used. For students who enroll in one of the regent's institutions, we will request course grade information for those students from the institution. Specifically, we will consider grades in subsequent courses and overall GPA. As before, it would be helpful to have similar data for students who are enrolling without the dual credit indication, or from students who have taken a course similar to the dual enrollment course at the regent's institution. It may be possible to use group level information. For example, each regent's institution publishes course grade information for each course at their institution, and it may be possible to use this information to compare the dual-credit students to all students using this information. If individual information is available, then adjustments can be made for prior achievement (e.g. ACT scores or course grade in the dual credit class).

At the conclusion of these analyses, the following questions can be answered:

- Do students who take college courses while in high school perform similarly in these classes to those who take the same courses in college (either a community college or a regent's institution)?
- Do students who take college courses while in high school perform adequately in classes that have the dual credit class as a prerequisite?
- Do students who take college courses while in high school perform adequately overall in college, compared to students of similar ability?
- How do students who take college courses while in high school compare to students who take the same course while in college in courses that have the dual credit class as a prerequisite?

3. Evaluation of the Course Rigor at Iowa Community Colleges and the Regent's Institutions

ACT proposes to evaluate the rigor of courses at both the 2-year and 4-year colleges, with the intent of evaluating the current level of rigor and comparing the consistency of rigor both within and between the 2-year and 4-year levels.

As part of this project, ACT is proposing to use a recently developed test, the QualityCore™ tests as the basis for this evaluation. The QualityCore tests were designed as a test for high school students to measure whether they have mastered the curriculum that would be taught in a rigorous high school course. Despite being designed for high school students, the tests are difficult, and contain material that would not be out of place in a typical first year college course. The QualityCore tests can be given on computer or with paper and pencil. The tests are 90 minutes in length and can include multiple choice tests only or a combination of multiple choice and free-response. Note that as part of this proposal, ACT could offer to reduce the test to a single 45 minute test, so as to fit within the bounds of a typical college meeting time

The first task will be to identify courses that are similar and taught at both the community colleges and the regent's institutions. We suggest that at least one course in English, mathematics, science, and the social sciences be designated. This will require some negotiation with the two sets of institutions. These courses need to be ones that enroll a large number of students, and could be considered as "gatekeeper" courses that are required for further study.

Once the courses have been designated, tests will be given at both the regent's institutions and the community colleges. We are proposing one section at each college, 18 sections total, with about 25 students per class. For the purpose of this proposal, we have assumed that 8 courses will be included. These are English/Writing, Biology, Chemistry, Physics, American History, Economics, Government, and Precalculus. If fewer courses are included, this would reduce the cost of the testing. Note that if testing is not required at all the community colleges, this would also reduce the cost. The tests would be given towards the end of the semester.

Based on this data, we can directly compare the performance of students at the community colleges and the regent's institutions directly by comparing scores on the tests. There will also be an adjustment for prior achievement, using ACT scores.
If community college courses are as rigorous, students at the two-year colleges should score as high as students at the regent's institutions, after adjusting for prior achievement.

At the conclusion of these analyses, the following question can be answered:

- Do students at community colleges have the same level of subject area knowledge after finishing a course as student at regent's institutions who have taken a course of a similar level?

Note that this particular methodology requires some cooperation on the part of the faculty at each institution, and this may be difficult to get. Issues of academic freedom and the appropriateness of the test being used may prevent the proposed analysis from taking place.

Summary

The proposed studies are all designed with one general question in mind. That is, do students who are taking a course at a community college get a similar academic experience compared to students who have taken the same class at a regent's institution? If that is so, then we should see that in subsequent courses, particularly those that have the prior course as a prerequisite, that both sets of students experience the same rate of success. The students in question could be students who have transferred to the regent's institution after starting out their college education at one of Iowa's community colleges, or it could be those who have received college credit as part of concurrent high school/college enrollment. What this document proposes is to track student success in college; either success in a subsequent course or success overall as measured by GPA. By comparing the success rates, we can evaluate the achievement of students who have taken the prior course at a community college, and compare that to the achievement of students who have taken the prior course at a regent's institution.

We believe that the proposed methodology is superior to methods where course syllabi or course final exams are compared. These methods are, by their nature, subjective. In the final analysis, if students are adequately prepared, then it should show in their subsequent course work. If they have received an educational experience that is deficient in some way, then this too will show in subsequent course work.

Work Plan

This section details the plan for accomplishing the tasks laid out in the prior section. For each task, a projected start data and end date are given.

Task 1.Success of Transfer Students

Component 1. Identify students who have transferred to a regent's institution from an Iowa community college. (Jeff Allen, Jill Crouse)

For this purpose we will use the data we already have from the Iowa community colleges. This represents 5 years of data from all 15 community colleges. Included are all grades from all classes. We will take these names (or a subset of these names), and send them to the National Student Clearinghouse for matching in subsequent years.

Start Date: January 1, 2009
End Date: February 1, 2009

Component 2. Obtain course grade information on select students in their first semester of enrollment at a regent's institution. (Jim Sconing, Jeff Allen, Jill Crouse)

Using the matched names obtained from the National Student Clearinghouse, we will contact each of the regent's institutions about getting grade data for these students for a specific semester or year. We would also ask for data from students in the same classes, but this may prove more difficult to get. Specifically, we would ask for an ACT score, and the course grade for each student in the class. If possible, we would also like to get prior course grades for each student in the class.

Start Date: February 1, 2009
End Date: May 1, 2009

Component 3. Match the two data sets together. (Jill Crouse, Joann Moore)

This involves putting together a data set that has as its elements:

Student identifier
Course identifier
Course grade in prior course
Course grade in subsequent course
Student GPA in community college (if available)
Student GPA in regent's institution
Student ACT score

This will require use to match the data provided by the regent's institution to the current community college data set, and to create the data set for analysis.

Start Date: May 1, 2009
End Date June 30, 2009

Component 4. Data analysis (Jill Crouse, Jeff Allen, Jim Sconing)

Run models linking performance in prior classes at the community college to subsequent performance in higher level classes at the regent's institutions. Run models linking performance in community colleges to overall performance (GPA) in classes at the regent's institutions.

Start Date: July 1, 2009
End Date: July 31, 2009

Component 5. Summarize results and write report (Jill Crouse)

Write a report summarizing the results with particular emphasis on the overall performance of the students who have transferred to a regent's institution from an Iowa community college in comparison with those who started at the regent's institution.

Start Date: August 1, 2009
End Date August 31, 2009

Task 2. Success of Students Enrolled in Dual-Credit Courses

The components, staff, and start and end dates for these are identical to those for task 1.

Task 3. Evaluation of Course Rigor at Iowa Community Colleges and the Regent's Institutions

Component 1. Arrange for testing with Iowa community colleges and regent's institutions (Jim Sconing)

Negotiate with each institution for cooperation with the project. The items that need to be hashed out include what tests to use, what courses to cover, and how to get faculty agreement to participate. Also, timing and delivery of the exams must be discussed and agreed on.

Start Date: December 15, 2009
End Date: March 15, 2009

Component 2. Testing of students

Tests must be delivered to institutions, along with all ancillary materials. A testing window of April 15 to May 15 will be used for schools on a traditional semester system. For any school that does not use this system, a testing schedule will be negotiated.

Start Date: March 15, 2009
End Date: May 15, 2009

Component 3. Test Scoring

Tests will be machine scored. If required, scores will be sent to each institution.

Start Date: May 15, 2009
End Date: June 15, 2009

Component 4. Analysis of test results (Jill Crouse, Jeff Allen)

Scores will be analyzed by college. If ACT test scores are available, these will be matched to student test scores and used for analysis. A comparison of those taking the course at a community college and those taking the course at a regent's institution will be made. Average scores for each institution will be calculated as well as score adjusted for prior achievement.

Start Date: June 15, 2009
End Date: July 15, 2009

Component 5. Summarize results and write report

Write a report summarizing the results. The comparison of the community colleges and the regent's institutions would be highlighted. One report for each course will be prepared.

Start Date: July 15, 2009
End Date August 15, 2009

<u>Task 4. Overall Summary of Project Results</u>

An overall report detailing each study will be prepared, and the final results and conclusions will be presented. (Jim Sconing, Jill Crouse, Jeff Allen).

Start Date: September 1, 2009
End Date: October 1, 2009

Overall Staffing Plan

The list below gives the approximate number of hours planned by staff person.

Jim Sconing Director, Statistical Research Department	200 hours
Jill Crouse Senior Research Associate, Statistical Research Department	550 hours
Jeff Allen Senior Research Associate, Statistical Research Department	100 hours
Joann Moore Research Assistant, Statistical Research Department	150 hours
Operations staff (coordinating the testing)	150 hours
Cathy Lacina Secretary, Statistical Research Department	75 hours

JAMES A. SCONING

Director
Statistical Research Department
Research Area

SUMMARY OF QUALIFICATIONS

- Theoretical and Applied Statistics
- Statistical Consulting
- Data Analysis

EXPERIENCE

As the Director of the Statistical Research Division, Dr. Sconing is responsible for the design and analysis of studies of the validity of new and existing services provided by ACT. His duties include the design of samples, collection of data, interpretation of results and development of new techniques for the analysis of data. He also conducts research into Mathematical and Applied Statistics as it relates to the programs and services provided by ACT. He is responsible for the oversight of the 11 members of the department and has responsibility for budgetary and administrative functions of the department.

Prior to joining ACT in June, 1992, Dr Sconing was a member of the faculty in the Department of Statistics and Actuarial Science at The University of Iowa where he was responsible for teaching a wide variety of courses on both applied and theoretical Statistics as well as doing methodological research in the area of mathematical statistics. He continues to serve as an adjunct faculty member at the university. He also spent one year as a visiting member of the Department of Mathematics and Statistics at The Memorial University of Newfoundland.

ACADEMIC BACKGROUND

B.S.(1979)	Mathematics and Economics	University of Pittsburgh
M.S.(1981)	Statistics	Florida State University
Ph.D.(1985)	Statistics	Florida State University

PROFESSIONAL ACTIVITIES AND ACHIEVEMENTS

Professional Memberships

American Statistical Association
Mathematical Association of America

Awards/Honors

University Scholar, University of Pittsburgh, 1978, 1979
Teaching Fellowship, Florida State University, 1979-81, 84-85
Ralph A. Bradley Award for the Outstanding Graduating Doctoral Student, 1986

Publications

Hollander M., Proschan F. and Sconing J.(1987) Measuring Information in Right-Censored Models. *Naval Research Logistics*,34,669-681.

Hollander M., Proschan F. and Sconing J.(1990). Information, Censoring and Dependence. *Topics in Statistical Dependence, IMS Lecture Note Series*,16,257-268

Conaway M., Pillers C., Robertson T. and Sconing J.(1990) The Power of the Circular Cone Test: A Noncentral Chi-Bar Square Distribution. *Canadian Journal of Statistics*,18,63-70.

Conaway M., Pillers C., Robertson T. and Sconing J.(1991) A Circular Cone Test for Testing Homogeneity Against a Simple Tree Order. *Canadian Journal of Statistics*,19,283-296.

Pommerich, M., Hanson, B., Harris, D., and Sconing, J.(2004) Issues in Conducting Linkages Between Distinct Tests. *Applied Psychological Measurement*, 28, 247-273.

Yin, P., and Sconing J. (2008) Estimating Standard Errors of Cut Scores for Item Rating and Mapmark Procedures: A Generalizability Theory Approach. *Educational and Psychological Measurement,* 68, 25-41.

Papers and Reports

Hollander M., Proschan F. and Sconing J.(1985) *Efficiency Loss with the Kaplan-Meier Estimator*. FSU Statistics Report M707.

Conaway M., Pillers C., Robertson T. and Sconing J.(1989) *Level Probabilities, Circular Cones and the Even-Odd Conjecture*. University of Iowa Department Of Statistics and Actuarial Science Technical Report #146.

Allen J. and Sconing J. (2005) *Using ACT Assessment Scores to Set Benchmarks for College Readiness* ACT Research Report 2005-3.

Jeff M. Allen

Senior Research Associate
Statistical Research
Education Division

SUMMARY OF QUALIFICATIONS

- Statistical analysis and modeling
- Dissemination of statistical results and technical writing
- Report and manuscript preparation
- Research data management
- Statistical consulting and research design
- Computer programming and statistical computation

EXPERIENCE

Since joining ACT in 2003, Dr. Allen has worked extensively in applied and theoretical educational research. He has worked on a wide variety of projects that support ACT's products and services, contribute to theories of college persistence and academic success, or inform ACT's marketing activities and operations. Dr. Allen has worked extensively on research projects involving postsecondary outcomes. His roles in the research projects have included data management, study design, statistical analysis and modeling, and dissemination of statistical results. Dr. Allen takes an active role in writing peer-reviewed journal articles as well as ACT Research Reports, case studies, and information briefs. Dr. Allen has also gained extensive experience with ACT's longitudinal EPAS data, which encompasses academic achievement in grades 8 though 12. Most recently, he has used this longitudinal data to demonstrate how school accountability models can be implemented.

ACADEMIC BACKGROUND

BA	Mathematics	Wartburg College, Waverly Iowa
MS	Biostatistics	University of Iowa
PhD	Biostatistics	University of Iowa

PROFESSIONAL ACTIVITIES AND ACHIEVEMENTS

Selected Publications

Allen, J. & Robbins, S. (2008). Prediction of College Major Persistence Based on Vocational Interests and First-Year Academic Performance. *Research in Higher Education, 49(1),* 62-79.

Allen, J. and Le, H. (in press). An Additional Measure of Overall Effect Size for Logistic Regression Models. *Journal of Educational and Behavioral Statistics*.

Allen, J., Robbins, S., Casillas, A. & Oh, I. (in press). Third-Year College Retention and Transfer: Effects of Academic Performance, Motivation, and Social Connectedness. *Research in Higher Education*.

Allen, J., Robbins, S., & Sawyer, R. (2008). Can Measuring Psychosocial Factors Promote College Success? Manuscript submitted for publication.

Robbins, S., Allen, J., Casillas, A., Akamigbo, A., Saltonstall, M., Cole, R., Mahoney, E., & Gore, P. (in press). Associations of Resource and Service Utilization, Risk Level, and College Outcomes. *Research in Higher Education*.

Robbins, S., Allen, J., Casillas, A., Peterson, C., & Le, H. (2006). Unraveling the differential effects of motivational and skills, social, and self-management measures from traditional predictors of college outcomes. *Journal of Educational Psychology, 98*, 598-616.

Allen, J., Robbins, S. (2008). Effects of Interest-Major Congruence, Motivational Skill, and Academic Performance on Timely Degree Attainment. Manuscript submitted for publication.

Allen, J., Jones, M.P., Cowles, M.K. (2006). Bayesian Modeling of College GPA Rate of Change with Informative Student Dropout. Unpublished manuscript.

Research and Policy Reports

March 2008. *The Relative Predictive Validity of ACT Scores and High School Grades in Making College Admission Decisions*. ACT Issue Brief. http://www.act.org/research/policymakers/pdf/PredictiveValidity.pdf.

March 2007. *Using EXPLORE and PLAN Data to Evaluate GEAR UP Programs*. ACT Policy Report. http://www.act.org/path/policy/pdf/gearup_report.pdf.

Allen J. and Sconing J. (2005) *Using ACT Assessment Scores to Set Benchmarks for College Readiness* ACT Research Report 2005-3.

Conference Papers and Presentations

Robbins, S., Allen, J., & Casillas, A. (July 2007). Why College Students Stay. Invited presentation at the 22nd Annual ACT Enrollment Planners Conference in Chicago, IL.

Robbins, S., Allen, J., & Sawyer, R. (April 2007). Do Psychosocial Factors Have a Role in Promoting College Success? Invited symposium at the NCME Annual Meeting in Chicago, IL.

Allen J., Le, H. (April, 2007). Measuring overall effect size of logistic regression models. Annual Meeting of the Society for Industrial and Organizational Psychology. New York, NY.

Robbins, S., Allen, J., & Sawyer, R. (August 2006). Do Psychosocial Factors Have a Role in Promoting College Success? Invited symposium at the American Psychological Association's Annual Conference in New Orleans, LA.

Allen J., Zhao, L. (August, 2004). Comparison of Fixed and Random-Effect Models for Predicting Cancer Incidence in Iowa. Annual Meeting of the American Statistical Association, Toronto.

Carney C.P., Allen J. (November, 1998). Delivery of Clinical Preventive Services to the Mentally Ill. 45th Annual Meeting of the Academy of Psychosomatic Medicine, Orlando, FL.

Honors and Awards

ACT Chairman's Merit Award, 2004
Milford E. Barnes Award for Academic Excellence in Biostatistics, 2003
Summa Cum Laude, Wartburg College, 1996
GTE Academic All-American, 1996
All-Conference Academic Team, Iowa Intercollegiate Athletic Conference, 1994-1996.
Recipient of Roy J. Carver Scholarship, 1994

JILL D. CROUSE

Senior Research Associate
Statistical Research
Education Division

SUMMARY OF QUALIFICATIONS

- Statistics and Measurement
- Validity study design and implementation
- Research service development
- Large-scale assessment
- Data collection and management
- Client consultation

EXPERIENCE

Dr. Crouse joined ACT in 1991. During that time, she has been involved in numerous projects. She was part of a team that developed the Course Placement Service, the prospect modeling component of the Enrollment Management Service, and is currently updating the Prediction Service.

As a senior research associate, Dr. Crouse has been the lead in designing and implementing validity studies for the ACT, COMPASS, and QualityCore tests. This includes the collection and management of sensitive data, data analysis and reporting of results. She has also worked on large scale projects with outside partners such as NAEP, GMAT, College Board, ETS and the Gates Foundation.

ACADEMIC BACKGROUND

BA	Biology	Wartburg College, Waverly, IA
MA	Educational Measurement & Statistics	University of Iowa
PhD	Educational Measurement & Statistics	University of Iowa

Joann Lynn Moore
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Tiffin, IA 52340
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Education

University of Iowa, Iowa City, IA, 2005 – present.
Ph.D. Educational Measurement and Statistics, expected 2010.

Montana State University–Bozeman, Bozeman, MT, 2003.
M.S. Applied Psychology.

Coe College, Cedar Rapids, IA, 2001.
B.A. Psychology, Minor in English, Cum Laude, Phi Beta Kappa.

Relevant Experience

ACT, Iowa City, IA, 2008 – present.
Graduate Research Assistant.

Center for Research and Evaluation, University of Iowa, Iowa City, IA, 2005 – 2008.
Graduate Research Assistant.

Montana State University–Bozeman, Bozeman, MT, 2001 - 2003.
Graduate Teaching Assistant.

Presentations

Moore, J. L., & Waltman, K. (2008). *State assessments vs. NAEP: How are states reporting the results from multiple measures?* Paper presented at the annual meeting of the American Educational Research Association, New York City.

Moore, J. L., & Waltman, K. (2007). *Pizza parties, pep rallies, and free parking: How common are these types of testing-related incentives/activities in Iowa schools?* Poster presented at the annual meeting of the Iowa Educational Research and Evaluation Association, Iowa City, IA.

Moore, J. L., & Waltman, K. (2007). *Pressure felt by teachers to increase test scores in reaction to NCLB: An investigation of related factors*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Work Product

The attached report details an investigation of the relationship between success in college and scores on the ACT. This report was used to create what are known as the College Readiness Benchmarks. These values are now used nationally as an indicator of the state of preparedness of students for college. They give a snapshot that can be interpreted by students, parents, teachers, administrators, and educational policy makers of the readiness of their students at a typical college.

The key similarities to the current proposal are the use of a complex data analysis to model the relationship between test scores and course grades. While the analysis may be complex the message from the analysis is simple and simple to explain. The fact that the results are empirically derived give them a power that cannot be matched by subjective evaluations of college readiness. These results have been cited in numerous publications and are one of the key markers that schools and states use to measure progress in educational attainment.

It would be valuable if the legislature could cite empirically driven research that demonstrates the success of students who transfer from community colleges to four year colleges, or of students who take dual credit courses, and wish to receive credit for these courses.

Using ACT Assessment Scores to Set Benchmarks for College Readiness

Jeff Allen
Jim Sconing

Abstract

In this report, we establish benchmarks of readiness for four common first-year college courses: English Composition, College Algebra, Social Science, and Biology. Using grade data from a large sample of colleges, we modeled the probability of success in these courses as a function of ACT test scores. Success was defined as a course grade of B or higher, and for each college the ACT test score that yields a .50 probability of success was identified. The median of these scores represents the college readiness benchmark—the score that would typically indicate a student is ready for first-year college courses. Benchmarks were obtained for four common first-year courses: English Composition, using the ACT English score as the predictor; College Algebra, using the ACT Mathematics score as the predictor; Social Science, using the ACT Reading score as the predictor; and Biology, using the ACT Science score as the predictor.

Using ACT Assessment Scores to Set Benchmarks for College Readiness

One of the biggest transitions in a student's career is from high school to college. College is currently viewed as the primary path to greater opportunity, to higher-paying and more rewarding jobs. As such, students, parents, and counselors put great emphasis on going to college. Of course, enrolling in college does not ensure success; a student must persist and obtain a college degree. Students who drop out usually do so in the first year of college (Choy, 2002), and one of the primary reasons is academic difficulty.

The ACT Assessment® provides an objective measure of students' academic achievement and readiness for college and includes four curriculum-based tests of educational development: English, mathematics, reading, and science. The ACT tests are designed to measure academic skills that are taught in typical college-preparatory curricula in high school and are necessary in the first year of college. High scores on these tests show that a student is proficient in these subject areas and is ready for college-level work. Thus, ACT scores may be used to help determine if a student is academically prepared for the first year of college.

Factors other than academic preparedness—such as motivation and good study habits—are also important to success in college (Robbins et. al, 2004). In addition, other measures—e.g., high school grade point average and the level of courses taken in high school —can offer significant information on academic preparedness. The advantage of using ACT Assessment scores is that they are standardized measures that sustain meaning across schools and years. The meaning of high school grade point average, on the other hand, can differ across high schools. In this study, we focus on ACT Assessment scores and their relationship to success in the first year of college.

The relationship between ACT Assessment scores and success in the first year of college has been well documented in previous studies (e.g., Noble & Sawyer, 2004; ACT, 1997). These studies use statistical methods, including linear regression and logistic regression, to relate ACT test scores to success in college. Other measures of success have been considered, including first-year college grade point average and grades in particular courses. These studies have shown positive relationships between ACT Assessment scores and success criteria, even after the effects of other factors (e.g., high school grades) have been statistically controlled for. In other words, the higher a student's ACT score, the more likely that the student possesses the skills and knowledge necessary for success in college.

In this study, grades in typical first-year college courses were modeled as a function of an ACT test score. The four courses studied were English Composition, College Algebra, Social Science, and Biology—courses that are taken by a large percentage of first-year students. The ACT Assessment scores used were English (with English Composition), Mathematics (with College Algebra), Reading (with Social Science), and Science (with Biology).

Many factors are associated with success in a particular course, just one of which is academic preparation. And, even at the same college courses may vary in content and grading practices. Thus, for any test, theoretically there is no score below which a student cannot possibly succeed or above which a student is certain to succeed. Therefore, in this study we modeled the probability of success in a course. If the test is a valuable tool for predicting success in a course, there should be an increasing probability of success as the test score increases.

For each course within each college studied, a cutoff score was chosen such that the probability of success was sufficiently high. For this study, we chose cutoff scores for which the probability of a grade of B or higher in the course is .50. The specific reasons for defining cutoff score is this way are given in the Research Methods section of this report. For each of the three courses studied, the cutoff scores varied across colleges. To establish a “benchmark” cutoff score, we calculated the median of the cutoff scores across colleges. The results are summarized in Table 1 below.

TABLE 1
Benchmarks for College Readiness, by Subject Area

Course	**ACT Assessment Test**	**Benchmark for Success**
English Composition	English	18
College Algebra	Mathematics	22
Social Science	Reading	21
Biology	Science	24

The benchmark values represent a summary across many colleges and many students. Because the material covered in a course and the grading practices within the course vary among colleges, these scores are not necessarily appropriate for every college. Instead, the *benchmark values* represent predictive indicators of success for *typical* students at *typical* colleges. They give students, parents, and counselors an easy and reliable guide—a standardized point of reference—as to whether a student has the knowledge and skills needed to have a reasonable chance of success in college.

Research Data

The data for this study came from colleges that had participated in ACT’s Course Placement Service, in which colleges send ACT student grades from a variety of courses. To obtain ACT test scores for each student, the student data were matched to the ACT Assessment data file using Social Security Number as the matching field. For each course, all colleges that supplied data for that course were included. If a college sent data from more than a single year, only data from the most recent year were included. In order to increase our sample size for the Social Science analysis, we considered five different courses (history, psychology, sociology, political science, and economics) because each is typically reading intensive. The number and types of colleges varied for the four courses we studied. Table 2 summarizes the colleges included in each sample by college type (two-year or four-year), region of the United States, enrollment size, and the number of students included in the sample. As Table 2 shows, the sample includes both two- and four-year colleges from each region and colleges of different enrollment sizes.

For English Composition, the sample contained 46 two-year and 46 four-year institutions. Since two-year and four-year colleges are equally likely to participate in the ACT Course Placement Service, it is not surprising that our sample has an equal number of each. Given that most ACT-tested students enroll at four-year colleges, it may seem misleading to apply study findings to ACT-tested students when the study itself is based heavily on two-year colleges. However, as detailed in Research Methods section (see page 13), we weighted the sample with respect to the academic preparation of the college's students in order to make the sample representative of all colleges. By so doing, we also addressed the oversampling of two-year colleges.

As shown in Table 2, the colleges in the four samples are not evenly dispersed with respect to geographical distribution. This is not problematic because we do not expect geography to influence the relationship between ACT test scores and success in first-year college courses. One reason for the geographical imbalance is that the ACT Assessment is more widely used in some areas than others. For instance, it is not widely used in the western region of the country;

thus, we expect less representation from this region in our sample than from a random sample of colleges.

TABLE 2
Description of Colleges in Sample

Course	Type	Region	Enrollment	Sample Size
English Composition	46 two-year 46 four-year	49% Southwest 27% Midwest 17% East 7% West	1st quartile: 1,137 Median: 2,475 3rd quartile: 7,014	Median: 322 Mean: 827
College Algebra	40 two-year, 45 four-year	46% Southwest 24% Midwest 20% East 11% West	1st quartile: 1,398 Median: 2,699 3rd quartile: 6,916	Median: 130 Mean: 398
Social Sciences	21 two-year, 24 four-year	27% Southwest 22% Midwest 38% East 13% West	1st quartile: 1,700 Median: 4,119 3rd quartile: 11,488	Median: 413 Mean: 1,193
Biology	17 two-year, 14 four-year	13% Southwest 29% Midwest 39% East 19% West	1st quartile: 1,746 Median: 3,341 3rd quartile: 11,836	Median: 76 Mean: 462

TABLE 3
Description of Students in Sample

Course	Sample Size	ACT Scores	% Successful
English Composition	76,122	1st quartile: 18 Median: 21 3rd quartile: 24	61%
College Algebra	33,803	1st quartile: 18 Median: 20 3rd quartile: 23	45%
Social Science	53,705	1st quartile: 18 Median: 22 3rd quartile: 26	54%
Biology	14,136	1st quartile: 20 Median: 23 3rd quartile: 25	45%

The median enrollment of full-time students at colleges in the English Composition sample was 2,475. The typical institutions represented in the College Algebra, Social Science, and Biology samples were larger (median enrollments of 2,699, 4,119, and 3,341, respectively). For English Composition, the median size of the sample within a college was 322, with a mean of 827. ("Size of sample" refers to the number of students for whom we have an English Composition grade and an ACT English test score.) The fact that the mean sample size was so much larger than the median sample size indicates that some colleges in our sample provided considerably more data than the "average" college in our sample. Relative to English Composition, colleges in the College Algebra and Biology samples typically had fewer students with course grade data. Partly due to the fact that multiple courses were considered, colleges in the Social Science sample typically had more students with course grade data.

For each college in each sample, we considered the average ACT Composite score of all enrollees within the past two years as an indicator of the academic performance of the college's students. The median of the average ACT Composite scores was 19 for English Composition, 19.1 for College Algebra, 19.3 for Social Science, and 19.2 for Biology.

In addition to characteristics of the colleges, we also considered characteristics of the students sampled (see Table 3). For English Composition, the total student sample size across all colleges was 76,122 and 61% of these students had a grade of B or higher in English Composition. The median ACT English score was 21, with a first quartile value of 18 and a third quartile value of 24. This can be compared to the ACT-tested graduating classes of 2002 through 2004. For this group, the median ACT English score was 20, with a first quartile value of 16 and a third quartile value of 24. We expected the sample to score higher than recent ACT-tested graduating classes since some students who take the ACT Assessment do not go to college.

For College Algebra, Social Science, and Biology, the total student sample sizes were considerably smaller than that of English Composition (33,803, 53,705, and 14,136, respectively). For College Algebra, the median ACT Mathematics score was 20, compared to the median score of 19 for recent ACT-tested graduating classes. For Social Science, the median ACT Reading score was 22, compared to the median score of 21 for recent ACT-tested graduates. For Biology, the median ACT Science score was 23, compared to the median score of 21 for recent ACT-tested graduates. Relative to the English Composition sample, the overall success rates were considerably lower for College Algebra and Biology: only 45% of the students had a grade of B or higher in both College Algebra and Biology. The overall success rate was also lower for Social Science as 54% were successful.

Research Methods

The Model

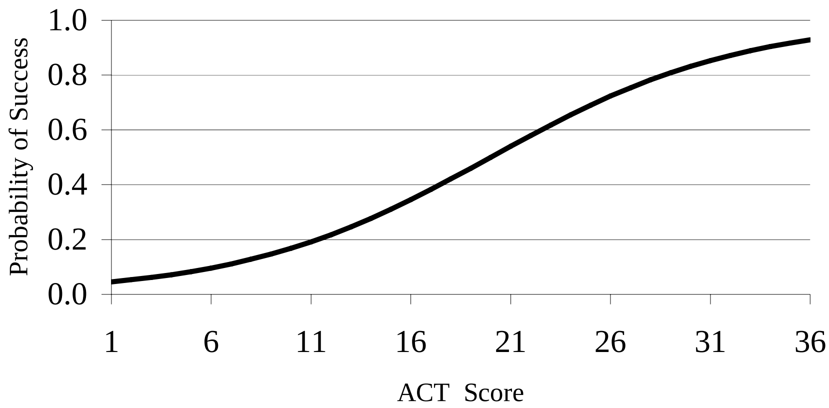
We investigated the relationship between an ACT test score and the grade a student achieves in a course by using a logistic regression model. In this model, course grades are divided into two categories: "success" and "failure." The probability of a success was then modeled as a function of the test score. This model is more appropriate for typical uses of test scores (e.g., admissions and course placement) than the more common linear regression/correlation model (see Sawyer, 1989, for further details).

Using the logistic regression model, we modeled the probability of success as a particular function of test score given by

$$\text{Probability of Success} = \frac{exp(\alpha + \beta x)}{1 + exp(\alpha + \beta x)},$$

where *x* represents a test score, *exp* represents the exponential function, and α and β represent an intercept and a slope that vary across colleges. To illustrate a logistic regression model, Figure 1 shows a graph of a typical relationship between ACT test score and probability of success.

FIGURE 1. Example of a Logistic Regression Model for Probability of Success by Test Score



Note that the curve increases as test score increases, indicating that students with higher scores have a greater probability of success in the course. The probability of success starts at a fairly low value and climbs to almost 1.0 when the test score is very high. The logistic model can accommodate a wide variety of shapes of this curve, depending on the values of α and β. The value of α determines the starting point of the curve, while β determines the slope of the curve.

The values of α and β were estimated for each college in our study sample and reflect the relationship between proportions of successful students and individual test scores. For example, a particular college might have had a 20% success rate for students with a test score of 15, a 50% success rate for students with a test score of 20, and an 80% success rate for students with a test score of 25. The values of α and β were chosen so that the curve for the college matched the observed proportions as closely as possible.

The curves for each college were estimated using a hierarchical logistic regression model. In this type of model, the curves are assumed to have some similarity to one another. For colleges with small sample sizes, estimation of α and β is more precise because we utilize the college's similarity to other colleges with larger sample sizes. As an alternative to hierarchical logistic regression, we could allow the estimation of α and β to be determined solely by the grades and test scores from each college. The drawback to this approach is that because some colleges provide only a small number of grades and test scores for a particular course, the estimates of α and β are insufficiently precise. The hierarchical model allows for the inclusion of colleges with small samples while at the same time improving the precision of the estimates of α and β by utilizing the college's similarity to the other colleges. (For more on the advantages of hierarchical regression models, see Raudenbush and Bryk, 2002.) For more details on the statistical procedures we used, see the appendix of this report.

Choice of the Success Criterion

To model the probability of success in the courses, we first determined what it means to be "successful" in a college course. Many would argue that a grade of C or higher is the correct definition, since a student who obtains such a grade has passed the course. However, in this study we defined success as a grade of B or higher in a course and identified three reasons why this option is preferable to the criterion of C or higher.

The first reason involves actual grading practices at colleges. Today, it's common for more than 50% of students in a course to earn grades of A or B. If course placement decisions were based on the student having at least .50 probability of earning a B or higher, then more than 50% of students would earn a B or higher (50% of the minimally qualified students would earn a B or higher), which is consistent with actual grading practices. On the other hand, if course placement decisions were made based on the student having at least a .50 probability of a C or higher, then a smaller proportion of students would earn a B or higher, which would not be consistent with actual grading practices. Thus, we believe that the score identified as necessary for a .50 probability of earning a B or higher is most consistent with actual grading practices used by colleges.

Another argument for using a B or higher success criterion is related to the policy implications of course placement. The score that gives the most accurate predictions is the score that would give a probability of success of .50. That is, any student who has a greater than .50 probability would be predicted to be successful, and any student with less than a .50 probability of success would be predicted to be unsuccessful. The result is that the least qualified student in the class would have about a 50% chance of being unsuccessful. If success is defined as a grade of C or higher, that means that the least qualified student would have about a 50% chance of earning a grade of D or F in the course. It would seem poor policy to place a student into a course when there's a 50% chance of earning poor grades. This is not the case with the B or higher criterion, as the least qualified student has a reasonable probability of earning at least a C.

Finally, due in part to "grade inflation", grades below C are fairly uncommon in most courses (Johnson, 2003). The statistical model we used attempts to predict the probability of success in a course, and the estimated cutoff scores will be less precise if either a success or a failure happens only rarely. Also, the parameter estimates that define the relationship between the probability of success and test score can be badly affected by a single unusual observation when there are few failures. To protect against this problem, the B or higher criterion is a superior choice.

For these three reasons, we believe the B or higher criterion is the best choice for the definition of success. This definition has been successfully used in ACT's Course Placement Service in the past and yields better results than those obtained with the C or higher criterion. Although the college readiness benchmarks were determined by the B or higher criterion, we also discuss results related to the C or higher criterion in the Results section of this report.

For each college and each course, the values of α and β were estimated using the hierarchical logistic regression model. From each estimated curve, the first point at which the probability of a success exceeded 0.5 was selected. This is referred to as the college's cutoff score for the course. From a decision theory point of view, this score point most accurately classifies the group into those who would be successful and those who would not be successful (see Sawyer, 1989).

Sample Weighting

It might be argued that since colleges in this study chose to participate in the Course Placement Service, they may not be representative of all colleges. In particular, there might be concern that the characteristics of the colleges in the sample might make their cutoff scores different from those of colleges that were not in the study. As previously mentioned, it is implausible that region of the country affects the relationship between test scores and grades in first-year college courses. Likewise, it seems improbable that a college's enrollment size or affiliation (public vs. private) would directly affect the relationship. However, one might argue that colleges whose students have different levels of academic preparation might have courses of different levels of difficulty and with different standards of grading. Therefore, we wanted our sample of colleges to be representative of all colleges in terms of students' academic preparation.

To make our sample more representative with respect to students' academic preparation, we weighted the individual cutoff scores. That is, to achieve a more representative distribution with respect to academic preparation, we counted some colleges more than others. The value that we used to measure the academic preparation of a college's students was the average ACT Composite score. A higher average ACT Composite score indicates that students are better prepared academically. For each college, the average ACT Composite score was calculated from the scores of all enrollees from the previous two years.

For each sample, we grouped the colleges by their average ACT Composite score. Since multiple courses with colleges were considered for the Social Science sample, we grouped each college/course combination by the average ACT Composite score of the college. The percentage of colleges (or college and course combinations) in each group for each of the four samples was compared to the percentage of colleges in that group nationwide. Each college (or college and course combinations) was then given a weight that was the ratio of the population percentage to the sample percentage. The definition of the groups and the weights for each group is given in Table 4 for English Composition, Table 5 for College Algebra, Table 6 for Social Science, and Table 7 for Biology.

Using Table 7 as a guide, we can see that the sample proportion of colleges with an average ACT Composite score less than or equal to 17.62 was .23, while for the general population, the proportion was only .16. Thus, in our study, we over-sampled colleges in this range of mean ACT Composite score. If the cutoff scores vary by range, this could affect our results. Thus, each college was given a weight of .69, which had the effect of counting these colleges less than others in our sample. Note that some colleges had weights greater than one and others had weights less than one. This depended solely on whether the colleges in that group of mean ACT Composite scores were over- or under-sampled. If all of the weights had been one, then our sample would have been perfectly representative of the population with respect to mean ACT Composite score. The purpose of weighting was to make the sample more representative of the population with respect to students' academic preparation.

In general, we tried to make the groups of about equal size and resulting in weights that were not drastically greater or less than one. With extremely large weights, we would be concerned that colleges in that group would be counted too heavily and unduly influence the sample median. Likewise, with extremely small weights, we would be concerned that colleges in that group would contribute little to the sample median.

TABLE 4
Weights for the English Composition Course Sample

Mean ACT Composite	Population Proportion	Sample		Weight
		N	Proportion	
≤ 17.62	0.16	21	0.23	0.68
17.63-18.62	0.13	20	0.22	0.61
18.63-20.37	0.27	26	0.28	0.96
20.38-21.62	0.15	10	0.11	1.35
≥ 21.63	0.29	15	0.16	1.80
Total	1.00	93	1.00	

TABLE 5
Weights for the College Algebra Course Sample

Mean ACT Composite	Population Proportion	Sample		Weight
		N	Proportion	
≤ 17.37	0.13	10	0.12	1.12
17.38-19.37	0.28	37	0.44	0.63
19.38-21.12	0.26	18	0.21	1.21
21.13-21.87	0.06	10	0.12	0.50
≥ 21.88	0.28	10	0.12	2.36
Total	1.00	85	1.00	

TABLE 6
Weights for the Social Science Course Sample

Mean ACT Composite	Population Proportion	Sample		Weight
		N	Proportion	
≤ 17.62	0.16	19	0.19	0.85
17.63-18.62	0.13	14	0.14	0.97
18.63-20.37	0.27	28	0.27	0.99
20.38-21.62	0.15	12	0.12	1.24
≥ 21.63	0.29	29	0.28	1.02
Total	1.00	102	1.00	

TABLE 7
Weights for the Biology Course Sample

Mean ACT Composite	Population Proportion	Sample		Weight
		N	Proportion	
≤ 17.62	0.16	7	0.23	0.69
17.63-18.62	0.13	4	0.13	1.02
18.63-20.37	0.27	8	0.26	1.06
20.38-21.62	0.15	4	0.13	1.14
≥ 21.63	0.29	8	0.26	1.13
Total	1.00	31	1.00	

Results

Recall that the cutoff scores may vary from college to college. To describe the variability in cutoff scores across colleges, three values were found: the median, the first quartile, and the third quartile. These values are given in Table 8 below.

TABLE 8
Summary of the Frequency Distribution of the Cutoff Scores

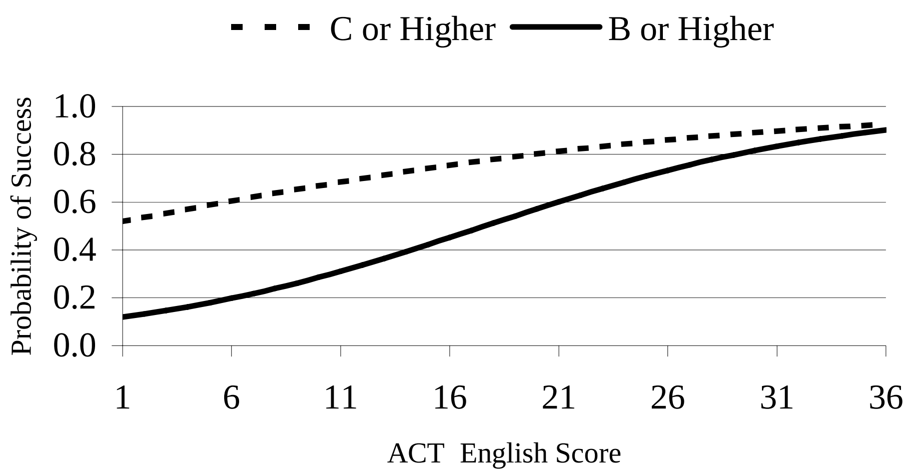
Course and Test	1st quartile	Median	3rd quartile
English Composition and ACT English Score	14	**18**	20
College Algebra and ACT Mathematics Score	22	**22**	23
Social Science and ACT Reading Score	17	**21**	24
Biology and ACT Science Score	22	**24**	25

The median values were considered typical values and so represent a good summary of the distribution of cutoff scores. Thus, the scores of 18 for English, 22 for College Algebra, and 24 for Biology represent benchmark ACT test scores that would give a student at the typical college a reasonable chance of success in these courses. Students with scores below the benchmark values would not be considered ready for standard college courses and may be in need of developmental work. Since the medians of the cutoff scores represented typical values needed for a .50 probability of success, we can use these values as overall standards for college readiness.

Although they are useful predictors of success in first-year college courses, ACT scores above the cutoffs do not guarantee success. For English Composition, 73% of the students in the sample had an ACT English score greater than, or equal to, their college’s cutoff score. Of these students, 69% earned a grade of B or higher, while 86% earned a grade of C or higher. In comparison, 39% of the students below their college’s cutoff earned a grade of B or higher, while 72% earned a grade of C or higher.

In Figure 2, we present the relationship between ACT English score and probability of success in English Composition for the typical college in our sample. Two probability curves are given: one represents the probability of a B or higher, and the other represents the probability of a C or higher. From Figure 2, we see that a student with a benchmark ACT English score of 18 has an 80% chance of earning a C or higher in English Composition at the typical college.

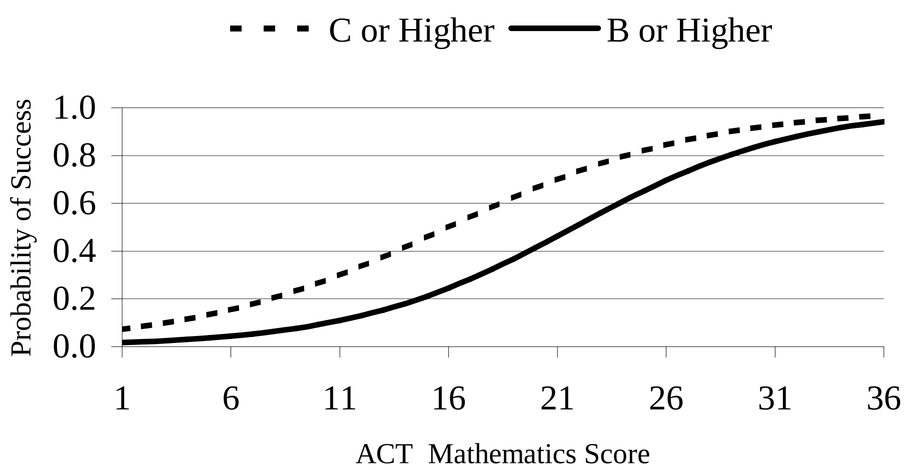
FIGURE 2. ACT English Score and Probability of Success in English Composition



For College Algebra, 36% of the students in the sample had an ACT Mathematics score greater than, or equal to, their college's cutoff score. Of these students, 64% earned a grade of B or higher, while 81% earned a grade of C or higher. In comparison, 34% of the students below their college's cutoff earned a grade of B or higher, while 61% earned a grade of C or higher.

In Figure 3, we present the relationship between ACT Mathematics score and probability of success (B or higher and C or higher) in College Algebra for the typical college in our sample. From Figure 3, we see that a student with a benchmark ACT Mathematics score of 22 has a 75% chance of earning a C or higher in College Algebra at the typical college.

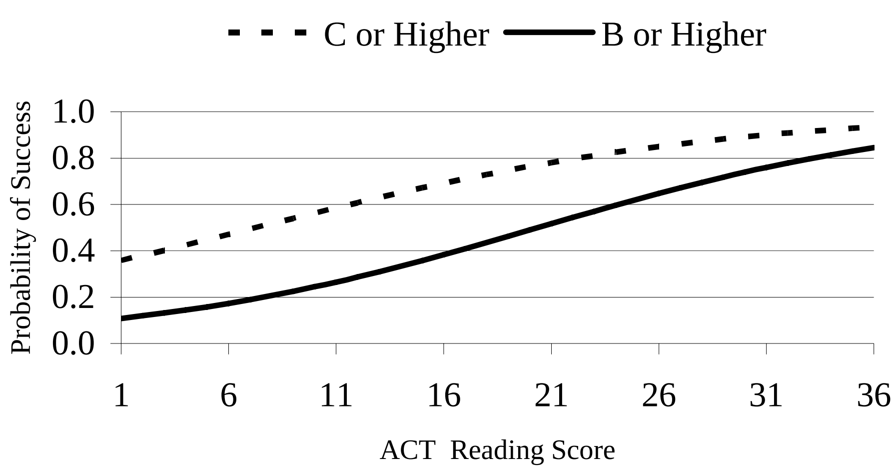
FIGURE 3. ACT Mathematics Score and Probability of Success in College Algebra



For Social Science, 62% of the students in the sample had an ACT Science score greater than, or equal to, their college's cutoff score. Of these students, 64% earned a grade of B or higher, while 86% earned a grade of C or higher. In comparison, 37% of the students below their college's cutoff earned a grade of B or higher, while 68% earned a grade of C or higher.

In Figure 4, we present the relationship between ACT Reading score and probability of success (B or higher and C or higher) in Social Science for the typical course in our sample. From Figure 4, we see that a student with a benchmark ACT Reading score of 21 has a 78% chance of earning a C or higher in Social Science at the typical college.

FIGURE 4. ACT Reading Score and Probability of Success in Social Science

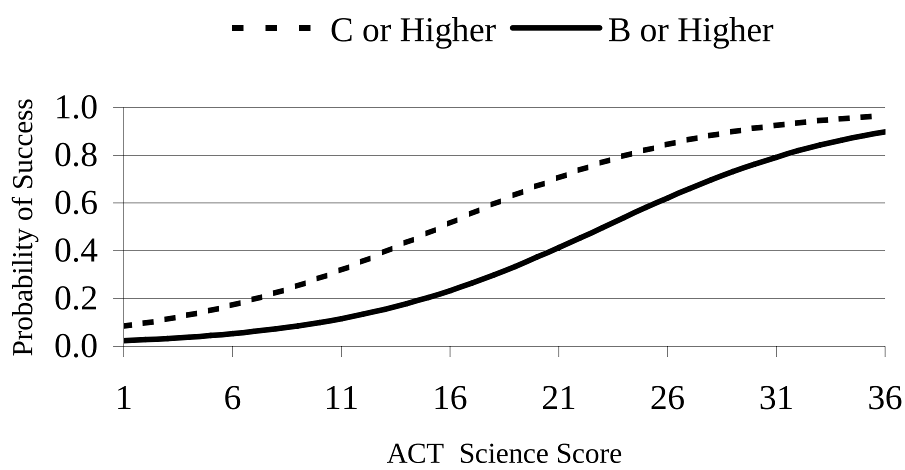


For Biology, 36% of the students in the sample had an ACT Science score greater than, or equal to, their college's cutoff score. Of these students, 62% earned a grade of B or higher, while 86% earned a grade of C or higher. In comparison, 36% of the students below their college's cutoff earned a grade of B or higher, while 68% earned a grade of C or higher.

In Figure 5, we present the relationship between ACT Science score and probability of success (B or higher and C or higher) in Biology for the typical college in our sample. From

Figure 5, we see that a student with a benchmark ACT Science score of 24 has an 80% chance of earning a C or higher in Biology at the typical college.

FIGURE 5. ACT Science Score and Probability of Success in Biology



Conclusion

Before investing the substantial resources needed to go to college, students and their parents need to know what it takes to be successful in college. In particular, students need to know if they are adequately prepared academically for the courses they will take. To help answer that question, we analyzed ACT test scores and grades in standard first-year courses for a representative group of colleges and established scores on the appropriate ACT tests that represent a .50 probability of earning a B or higher in each course at a typical college. We think of these scores as benchmarks for success in these courses.

The courses considered were English Composition, College Algebra, Social Science, and Biology. For the English Composition course, the test score representing the benchmark for success was an 18 on the ACT English test. For College Algebra, the benchmark score was a 22 on the ACT Mathematics test. For Social Science, the benchmark score was a 21 on the ACT Reading test. For Biology, the benchmark score was a 24 on the ACT Science test. Students, parents, and counselors can use these scores to determine the academic areas in which students are ready for college coursework and the areas in which they need more work.

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Appendix: Hierarchical Logistic Regression Model

For each college/course combination included in the sample, a cutoff score was found that represents the ACT test score that gives a .50 probability of success in the college/course. We modeled the probability of success using the logistic function as follows:

$$\text{Probability of Success} = \frac{exp(\alpha + \beta x)}{1 + exp(\alpha + \beta x)},$$

where x represents a test score, *exp* represents the exponential function, and α and β represent an intercept and slope that vary across college/course combinations. The test score that gives a .50 probability of success is found by solving the probability equation for x as follows:

$$.50 = \frac{exp(\alpha + \beta x)}{1 + exp(\alpha + \beta x)} \text{ implies that } exp(\alpha + \beta x) = 1 \text{ and } \alpha + \beta x = 0 .$$

Hence, $x = -\alpha / \beta$ is the test score that gives a .50 probability of success. Since scores on the ACT test can only take integer values, the cutoff score was set to $-\alpha / \beta$, rounded to the next highest integer.

To estimate the values of α and β for each college/course combination, a random-coefficients logistic regression model was used. This type of model is often referred to as a hierarchical logistic regression model. For each course, we assumed that a college's α and β coefficients are drawn from a bivariate-normal distribution, with mean vector denoted (μ_α, μ_β), and an unstructured variance-covariance matrix denoted Σ. For each course, the parameter estimates, standard errors, and 95% confidence intervals are given in Table 9. The implications of this model are that, for each college, α and β are estimated based upon data for that college, as well as the average values of α and β across colleges. The NLMIXED procedure within SAS statistical software was used to fit the model and obtain the estimates of α and β for each college. For more details on SAS PROC NLMIXED, see SAS (1999).

TABLE 9
Parameter Estimates From Hierarchical Logistic Regression Models

English Composition and ACT English Score				
Parameter	Estimate	Standard Error	95% confidence interval	
			Lower Bound	Upper Bound
μ_α	-2.1195	.1389	-2.3954	-1.8437
μ_β	.1204	.0055	.1095	.1313
Σ_{11}	1.2849	.2509	.7864	1.7835
Σ_{12}	-.04286	.0093	-.0613	-.02442
Σ_{22}	.00167	.00036	.00095	.00239
College Algebra and ACT Mathematics Score				
Parameter	Estimate	Standard Error	95% confidence interval	
			Lower Bound	Upper Bound
μ_α	-4.2524	.2086	-4.6672	-3.8375
μ_β	.1954	.0094	.1767	.214
Σ_{11}	2.0689	.5433	.9884	3.1494
Σ_{12}	-.0819	.0227	-.1270	-.03686
Σ_{22}	.00383	.00099	.0019	.0058
Social Science and ACT Reading Score				
Parameter	Estimate	Standard Error	95% confidence interval	
			Lower Bound	Upper Bound
μ_α	-2.2121	.1304	-2.4708	-1.9533
μ_β	.1085	.0046	.0994	.1177
Σ_{11}	1.2805	.2471	.7902	1.7709
Σ_{12}	-.0365	.0082	-.0527	-.0202
Σ_{22}	.00128	.00029	.00070	.00186

Biology and ACT Science Score				
Parameter	Estimate	Standard Error	95% confidence interval	
			Lower Bound	Upper Bound
μ_α	-3.8933	.2845	-4.4751	-3.3114
μ_β	.1687	.0120	.1441	.1933
Σ_{11}	.9104	.4358	.01903	1.8018
Σ_{12}	-.0254	.0145	-.0550	.0042
Σ_{22}	.0008	.0005	0	.0019

A Proposal to the Legislative Services Agency in Response to its Request for Proposals: Postsecondary Education Rigor Analysis

Postsecondary Education Rigor Analysis

Business Proposal

Submitted by ACT, Inc.
November 7, 2008

Task 1	Success of Transfer Students	$121,220
Task 2	Investigation of Dual Credit	85,510
Task 3	Evaluation of Course Rigor	80,350
	QualityCore Assessments (up to 3600 tests)	61,200
Task 4	Progress and Final Reports	8,070
	Total	$356,350