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Join the Conversation Uniting Mathematical Modeling and Statistics: Data Analysis in the College Classroom

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Abstract

The purpose of this article is to describe the development of a preparatory course in mathematical modeling. With the spread of mathematical modeling courses through public universities in the United States and the decline in the availability of developmental studies courses across the nation, such preparatory courses are important for students who are insufficiently prepared for mathematical modeling courses. I describe considerations that went into the development of a course uniting statistics and mathematical modeling, including the theoretical framework. Finally, I provide general suggestions for learning centers that might want to implement such a preparatory course.

The traditional track of mathematics courses has been designed to prepare students for calculus. Typically, this has involved the study of algebra and trigonometry in high school with further study of algebra (i.e., college algebra) and trigonometry in college. In some cases, college algebra and trigonometry are united into a single course called precalculus. College algebra and precalculus typically form the focus of the mathematics requirements in a core or common curriculum at colleges and universities. Often these requirements are to be completed within the first 2 years of a student's entry into the postsecondary institution. Some well-prepared students are able to take calculus immediately upon entering college, but many find it necessary to take precalculus.

More recently, some institutions have begun to offer courses such as statistics or mathematical modeling that can also satisfy the mathematical requirements of a core curriculum instead of replacing college algebra and precalculus. In some cases, the particular mathematics course that students take is determined by their major. Mathematical modeling courses ask the students to construct mathematical models that allow students to make predictions and to gain a better understanding of the data.

The development of a core curriculum mathematics modeling course at the University of Georgia prompted the subsequent development of a course to help prepare students for the mathematics modeling course. The decision was made to repurpose a course that was designed to prepare students for introductory statistics so that it would prepare students for mathematical modeling as well as statistics. The course was located within the Division of Academic Enhancement, a division whose mission is to support

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the learning of students at the University of Georgia. The statistics course was to retain elements of preparation for statistics and yet be expanded to incorporate preparation for the mathematical modeling course. The course uniting preparation for statistics and mathematical modeling would be titled "Introduction to Data Analysis." The purpose of this new course would be to help students develop the concepts and knowledge required to be successful in the mathematical modeling course taught by the mathematics department of the University of Georgia as well as develop a good understanding of statistics.

The blending of statistics and mathematical modeling was a natural and logical one. From a content standpoint, mathematical modeling and statistics courses are complementary in their content. While both courses deal with data, statistics emphasizes descriptive and inferential statistics (e.g., means, medians, significance testing) and typically ends with linear regression, the act of creating linear models that best fit data. On the other hand, mathematical modeling courses typically begin with finding linear models of best fit and continue to include curves of various types. The mathematical modeling courses involve the use of different types of functions to describe data. Further, most mathematical modeling courses include an emphasis on technology and some also require a greater understanding of algebra than would be expected in a statistics course.

The primary difficulty in designing the course was successfully uniting the statistics thread and the modeling thread. Each thread could have been taught independently of the other, effectively making the course a two-part course. Doing so would squander the opportunity to merge the two threads together. Rather than keep them separate, a part of the statistics course, the analysis of variance, was woven together with the modeling course. Analysis of variance includes topics such as mean and standard deviation and variance. Regression, the act of finding models that best fit the data, was presented as a way to explain the variance in the data. Regression provided a smooth transition from descriptive statistics to mathematical modeling. The introduction of nonlinear functions was a natural extension of the analysis of variance.

Theoretical Framework

The National Council of Teachers of Mathematics' standards for data analysis (Burrill, et.al, 1992; Burrill, Franklin, Godbold, & Young, 2003) for grades 9 through 12 called for students to develop facility with many aspects involved with working with data. These include formulating questions, using appropriate statistical methods with the data, and making inferences and predictions based on the data. With only one semester to prepare students for a rigorous mathematical modeling course, it is necessary to prioritize the different components of data analysis. Two of the aspects of data analysis form the focus of the course: using appropriate statistical methods and making inferences and predictions based on the data. Students have to understand, represent, and explore data.

Understanding data is itself subdivided into two components, understanding relationships among data items and meaningfully interpreting the data items. Representing data is subdivided into summarizing data, including descriptive statistics,

graphing data, and modeling data. The third aspect of exploring data involves making and interpreting in a meaningful way predictions about data, using data to draw conclusions about questions, and writing about the data and its implications. The three aspects and their eight components are listed in Figure 1.

Understanding Data	Representing Data	Interpreting Data
Relations among data items	Describing data using statistics	Predicting using data
Interpret data in practical terms	Graphing data	Drawing conclusions from data
Modeling data	Writing about data	

Figure 1. Aspects of data analysis.

The eight components are viewed as threads that are woven throughout the course, uniting descriptive statistics with mathematical modeling. Although data is taken as much from the real world as possible, it is the questions and the tasks using the data that encourage the development of students' thinking toward the goals of being flexible and fluent in all three aspects of mathematical modeling.

Another thread that is incorporated into the course is the use of technology, particularly that of a graphing calculator. The eight threads—relations among data items, describing, graphing, modeling, and interpreting data; predicting with data; making conclusions from data; and writing about data—all involve the use of technology. The technology used in the course allows students to explore and verify hypotheses. It allows them to solve equations that they might not be able to solve algebraically. In addition, the mathematical modeling course that the students may be taking to meet a core curriculum requirement relies heavily on the graphing calculator to solve and graph equations, analyze the data statistically, and obtain models for the data. Students preparing to enroll in math modeling in the future will need to use the graphing calculator technology with facility.

The theoretical foundation that guides the approach to the eight threads and the selection of problems and exercises is a Piagetian (1971) framework called radical constructivism (Von Glasersfeld, 1995). In this framework, cognition utilizes mental operations such as embedding and disembedding, integration of parts into wholes, fragmenting or partitioning wholes into parts, and other highly-interiorized, self-contained cognitive processes. These mental operations can be combined into schemes of action and operation that students use to reason and act mathematically. For example, a student might have a scheme for solving a linear equation like $3x + 2 = 17$.

The difference between a scheme and procedures or strategies lies in the viewpoint taken by an observer. Observers who refer to the student's actions, both mental and physical, as "strategies" consider strategies as an object of instruction, something to be taught. Under this viewpoint, the strategy has an existence independent of the student

and the teacher. Observers who refer to the student's actions, both mental and physical, as "schemes" consider schemes to be mental constructs made by the student. They are a part of the student's thinking and understanding and have no existence apart from the student.

Conceptual knowledge and procedural understanding are emphasized in the course. Students are expected to understand both the foundational concepts of what they are learning as well as how to implement these concepts procedurally. Procedures learned without the conceptual material underlying them are easily confused or forgotten. Without the conceptual understanding of the material, students are unable to integrate the parts of the course into a coherent whole. Schemes embody both declarative and procedural knowledge. This approach is in sharp contrast to the traditional approach of teaching procedures with the hope that concepts will develop.

Helping students to construct more viable mathematical operations and schemes is essential in the development of conceptual and procedural knowledge. For example, schemes involving the construction and manipulation of quantity are important so that students will better understand mean and median. Concepts of rate are important so that students can better interpret the slope of a line of best fit because that slope is a rate. Developing a robust function concept (Markovits, Eylon, & Bruckheimer, 1988; Smith, 2003) is an important part of the course because of the emphasis on functions in mathematical modeling.

One key strategy to help students construct and improve their mathematical schemes is reversal. For instance, instead of finding the mean of a set of numbers, students are asked to also find numbers that have a particular mean. This process encourages students to step back and examine their scheme for finding a mean and using it as an object of thought. This process of examination can move the scheme to a deeper level. The threads of interpreting data, writing about data, and relations among data items are designed to encourage the reexamination of schemes.

Course Outline

The overall outline of the course is roughly divided into two parts. The first part focuses on describing data and, more specifically, on descriptive statistics. The second part focuses on mathematical models: what it means to model data, how to choose an appropriate model, and interpretation and predictions based on the model. Throughout the second part, concepts developed in the first part reappear.

An important part of the relations among data items thread is the study of how the quantities described by the data change. The study of change among data items is an important part of both statistics and mathematical modeling and falls into both parts of the course. For example, in statistics quantities like mean are compared before and after a treatment. In mathematical modeling, interpreting the slope of a line as a rate of change is an important concept. The average change over time is another important concept. The study of change also falls into the graphing data, modeling data, and interpreting data threads.

Numerical and Percent Difference

The study of descriptive statistics begins with the study of both numerical and percent difference. The two forms of differences provide ways of comparing data items and so fall under the relations among data items thread. In addition, the topic provides an opportunity to try to strengthen students' understanding of ratios and rates.

Although numerical difference, the difference between two numbers, is a quantity readily constructed by children during the early years of schooling (Piaget, 1952), percent difference is a more difficult concept involving ratios. Research has shown that rates and more generally ratios have a much longer development time and presuppose the existence of a number of mental operations (Behr, Harel, Post, & Lesh, 1992; Carraher, 1996; Steffe, 2001; Steffe & Olive, 1990). Difficulties with ratios arise in part because ratios involve multiple concepts. Ratios involve concepts of division, fractions, measurement, and part-whole (Behr et al.). Each of these concepts develops at its own pace. There are indications that part-whole and fraction operations are still not completely developed in some college-age students (Biddlecomb, unpublished manuscript). College-age students have developed the comparisons of parts that are still in a whole and parts that are disembedded from a whole. Their difficulties lie in areas of recursion: parts within parts within wholes, such as fractions of fractions.

Therefore, the initial emphasis in the course is procedural and conceptual development of percents through the use of percent difference. This is accomplished through procedural exercises. For example, students were given a table of counties and their populations in 2000, 2001, and 2002. They were asked the following procedural question that required them to calculate percent differences:

For each county in Table 2.1 [the table of counties], calculate the percent difference between the population in 2000 and 2001. Calculate the percent difference between the population in 2001 and 2002. Finally, calculate the percent difference between the population in 2000 and 2002.

Conceptual development is also encouraged through exercises that target some of the weaknesses students have, such as conceptualizing percentages as a rate and conceptualizing percentages of percentages. Some example questions include:

1. Calculate the percent difference in population for each county in [a table of populations of counties in the years 2000, 2001, and 2002] for 2000 to 2001, 2001 to 2002, and from 2000 to 2002. If you were to predict the population of the county for 2003, which of the percent differences would you use as your growth rate?
2. Choose one county from [the table of populations of counties in the years 2000, 2001, and 2002]. Calculate the percent difference in population from 2000 to 2001 and 2001 to 2002. By how many percentage points has the growth rate increased from 2000-2001 to 2001-2002? By what percent has the growth rate increased? What would you predict for the growth rate for 2002-2003? Explain your prediction.

Question 1 is designed to encourage the interpretation of percents as a rate. Question 2 is designed to build on the interpretation of percents as a rate, but also to encourage

the conceptualization of percents of percents. Also, notice in Question 2 that there are at least two viable answers for the question: "What would you predict for the growth rate for 2002-2003?" One involves a simple linear increase in the growth rate using the difference in percentages calculated for 2000-2001 and 2001-2002. The second involves an exponential increase using the percent increase in the growth rate between 2000-2001 and 2001-2002. The existence of multiple viable answers can occasion a cognitive dissonance that engenders a reexamination of the rate concept. These questions have the threads of relations among data and predicting using data woven into them.

Mean and Median

Following numerical and percent differences, the quantities mean and median are introduced to the students as ways of summarizing data. All of these quantities fall under the thread of describing data using statistics. The difference between mean and median can be a difficult one for students to understand. Students understand the need to describe the middle of a set of data items, but are unaware that there are at least two ways to think about the middle of a data set. While the mean is the middle in terms of the values of the data items, the median is the middle in terms of the number of the data items. The distinction between mean and median echoes the distinction between numerical and percent difference in which students learned there are two ways to think about "fastest growing." The following questions are designed to emphasize the distinction:

1. Use lists and your calculator to find the mean amount of U. S. savings from 1970 to 2003. For what percentage of years were savings above average and for what percentage of years were they below average? Be sure to write your answer in paragraph form.
2. Use your calculator to find the median value of U. S. savings from 1970 to 1999. For what percentage of years were savings above the median and for what percentage of years were they below the median? Be sure to write your answer in paragraph form

The writing about data thread is woven through these questions.

In addition to promoting procedural knowledge through calculations of the mean and the median, emphasis is also placed on the interpreting data in practical terms thread by asking students to interpret the mean and median of distributions:

1. If you were asked to predict how much money would be saved in the year 2004, what would be your prediction and why?
2. Why are the mean and median different? Your answer should focus on the values of the data items and the number of data items.

Reversibility is important to the development of mental operations and conceptual knowledge (Piaget, 1952). Tasks that ask students to reverse their usual way of acting can occasion the reprocessing of schemes because the scheme is used as an object of thought; the scheme can, in a sense, be held out at arm's length by the student and examined to see the steps followed in the scheme with an eye to reversing them. This is accomplished by using the operations of the scheme as input for other schemes.

Exercises such as the following are used to encourage construction of such reversibility with regards to the concept of a mean:

Construct a set of numbers that satisfy the following criteria. There are many possible correct answers.

- A. Five numbers with a mean that is a member of the set.
- B. Four numbers with a mean that is a member of the set.
- C. Five numbers with a mean that is not a member of the set.
- D. Four numbers with a mean of 3.5.

Variance and Standard Deviation

The descriptive statistics section of the course continues with the introduction of variance and standard deviation. The deviation of a single data item from the mean is introduced to the students numerically and visually. To approach the subject numerically, the students merely subtract the mean from the data item to find the deviation. At this point, the instructor typically asks them to add up the deviations. Some are surprised when they get zero as a result. The students are asked to make up some numbers, compute the mean and the deviations again, and then sum the deviations. Because they again get zero, someone almost always asks whether they would always get zero.

To approach deviations visually, a software program called Geometer's Sketchpad by Key Curriculum Press (Jackiw, 2001) is used. The goal of the software is to teach geometry in a dynamic fashion; that is, objects can be moved around and the relationships between them remain fixed. For the purposes of introducing deviations and variance, a sketch has been constructed in which the data points can be manipulated along a number line and a line representing the mean changes position in response to the changes in the data points. This visual approach is part of the graphing data thread in Figure 1., provided on page 43.

Following the introduction of descriptive statistics, tables and graphs are introduced as two of the four ways of representing data: in words, tables, graphs, and functions. The choice to represent data in these four ways arises from the representing data aspect of the course as shown in Figure 1.

The representing data aspect of the course is finished with the introduction of functions as a way of describing data. Functions are introduced as a relationship between two quantities. One quantity is designated the independent variable and the other the dependent variable. The choice of independent and dependent variable is a matter of convenience and the terms do not necessarily reflect a causal relationship.

Mathematical Modeling

The remainder of the course focuses on mathematical modeling. Basic concepts of lines such as slope and intercepts are introduced in general terms. Linear models

are introduced as ways of visualizing the trends in data. The students find the linear functions for the models and interpret the slopes of the models as average rates of change. To encourage the development of slope and rate as interchangeable concepts, students are asked to find the average rate of change of the data. Using the average rate of change as a slope, students are able to construct linear functions that model the data.

The sum of the squares of the errors, the amount by which the actual data differs from the predictions, provides a motivation for a line of best fit. Such a line makes the sum of the squares of the errors as small as possible. I again use a sketch in the Geometer's Sketchpad to show a visual representation of the idea of a best fit line. The recommended calculator for the course, the Texas Instruments TI-83, makes finding the best fit linear model an easy exercise.

The tools developed in connection with linear models are also applicable to quadratic models, models involving second powers of the independent variable, cubic models, models involving third powers, and exponential models. The concept of the model explaining the variance in the data allows for the comparison of how well each model fits the data. The students are given data and asked to determine which model best fits the data.

The students also receive writing projects throughout the course. In these projects students receive data that they must analyze using the descriptive statistical techniques taught in the course and construct a model for the data. In some cases, they must decide which type of function best models the data. Some projects require the students to make predictions using one or more models. The students are asked to draw conclusions from their models. For example, in the final exam one semester, students were asked to predict United States energy consumption and production for the year 2020. Students had to write about the implications of their findings for political, economic, and social life in the year 2020.

Implications for Learning Centers

Institutions offering mathematical modeling courses as part of the core curriculum provide new challenges and new opportunities for learning support centers. Mathematical modeling courses are now offered at many colleges and universities as part of the core curriculum (e.g., United States Military Academy, Georgetown University, Kennesaw State [GA] University, and the University of Northern Iowa). The target audience for such courses is students who do not intend to major in the sciences. These are frequently liberal arts majors. Many students in the target audience are uncomfortable with algebra and precalculus or have not developed the mathematical knowledge needed to be successful in algebra or precalculus. Some mathematical modeling courses focus more on the algebra behind the mathematical modeling while others focus more on obtaining models from the data. A significant amount of algebra is taught in the mathematical modeling course at the University of Georgia taught by the mathematics department and is a possible contributor to a nonsuccess (i. e., withdrawal or a grade of D or F) rate of 25% in that mathematical modeling course.

If the nonsuccess rate at the University of Georgia is comparable to that at other

institutions, then clearly it is important for learning support centers to develop courses or workshops to help students prepare for mathematical modeling courses. Such preparatory courses or workshops can focus on the current mathematical knowledge of students with the intent of modifying their mathematical knowledge into that required for the subsequent mathematical modeling course. The guidelines in this article can provide a framework for structuring a course or series of workshops that are tailored to particular institutional needs.

Conclusion

A theoretical foundation informed by both constructivist theory and aspects of data analysis provides a framework for uniting statistics with mathematical modeling in a way that encourages rich concept formation. By focusing on students' schemes as a part of their mathematical development, we are able to produce an integrated approach to both statistics and modeling. Problems and tasks that target schemes and operations common to both statistics and mathematical modeling, such as the coordination of quantities and reversibility, are incorporated into the course.

Constructivist theory led to the development of eight threads. These eight threads weave their way through the course. For example, the topic of percent and numerical difference incorporates relations among data items as well as interpreting the data in practical terms thread. Interpreting data appears later in the course in the context of writing assignments and projects. In taking a viewpoint that encouraged understanding mathematical thinking as made up of schemes and operations, I was able to interpret mathematical difficulties that students have in terms of poor development of those schemes and operations. For example, both my experience and Piagetian research (Lamon, 2001; Piaget, Inhelder, & Szeminska, 1981; Steffe, 1997) have shown that students have difficulty coordinating two co-varying quantities such as occur in ratios and rates. Radical constructivist theory informs me that the coordination of these two quantities requires the interiorization of these quantities on a deep level (Thompson & Thompson, 1996). Therefore, exercises are given to the students that encourage the production and coordination of such quantities, both forming ratios and rates from the quantities and, reversing the process, quantities from the ratios and rates. Almost every exercise that asks students to reason in one direction can be reversed. For example, rather than only asking students to find the mean of a set of numbers, they can also be asked to find a set of numbers that have a given mean.

The entry of mathematical modeling courses into the core curriculum provides learning support centers with new challenges and new opportunities. In my experience at the University of Georgia, I have found that students who have lacked confidence as a result of their high school algebra courses have felt much more confident after taking my preparatory course. Others have said that they believe they have a better understanding of one or more topics than they had before taking the class. Learning support centers have the challenge of working with students in need of mathematical preparation. But they also have the opportunity of helping these students view mathematics in a new light.

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Book Review

The Pedagogy of Possibilities: Developmental Education, College-level Studies, and Learning Communities.

Malnarich, G. and Others (2003). *The pedagogy of possibilities: Developmental education, college-level studies, and learning communities*. National Learning Communities Project Monograph Series. Olympia, WA: The Evergreen State College, Washington Center for Improving the Quality of Undergraduate Education, in cooperation with the American Association for Higher Education.

Reviewed by Julianne Scibetta, Administrator of Tutorial Services and Summer Bridge, University of the Sciences, Philadelphia, PA.

Giillies Malnarich's monograph, *The Pedagogy of Possibilities*, intends to uncover the basic principles of developmental education and how building learning communities can help attain those goals. It is a comprehensive introduction, complete with a review of the history of developmental education and learning communities, and detailed case studies to aid those interested in adapting educational models of their own.

Chapter 1 provides interesting insight into eight characteristics that make a student "at risk" of not completing a program or degree—candidates for developmental education—and how those factors combine to create a survival mode in students consisting mainly of surface learning. Obviously such an approach to learning is contrary to developmental teaching. Another factor addressed in the monograph that affects the successful outcome of a developmental program is the misalignment of high school completion requirements and entering college-level expectations that create a "basic skills crisis" (p. 2). Malnarich explores the crucial part institutional resources play in the success of developmental programs and the traditional attitudes held by faculty and administration alike that hinder a program's progression. Malnarich then begins to raise questions about the viability of developmental education programs.

In Chapter 2 Malnarich traces the history of developmental education and theory back to the mid-1800s. Also in this history is the inclusion of women and people of color in higher education and the philosophy behind the creation of community colleges. Malnarich explores how the goals of developmental education programs have changed to facilitate deep, effective learning that can be applied interdisciplinarily. Malnarich introduces some of the best practices in the field in general: aiding students in overcoming all areas of barriers, including financial; honesty about the preparation of

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students and advocacy to take appropriately-leveled courses; and connecting with high schools and transfer colleges for a seamless transition. She also begins examining some of the prominent characteristics of successful programs, including connecting education with applicable interdepartmental material and everyday life.

In Chapter 3 the monograph categorizes developmental education programs into four broad groups. These groups are based on several key characteristics: (a) developing a campus partnership, (b) working at the right level of development, (c) integrating curriculum with skills, and (d) offering a holistic program. Chapter 3 provides short examples of how programs in each of these four categories are structured and operate within the institution, along with stories of assessment of the programs. Malnarich further discusses where these programs should fall and how to assess that placement on each individual campus. For instance, her recommendations on ascertaining a fit are to target the program toward high risk classes, to identify any particular demographics of students who experience high risk for that course, and to gather practical information from the frontline (e.g., advisors, students, etc.) to see if it is a viable need. Short summaries of selected programs by contributing authors lead us into the final essay—the afterword, “A Call to Action,” Malnarich’s reality check.

In spite of the dramatic gains of developmental education, she says, there are larger forces working against the field. On the one hand, developmental educators extol the virtues of the programming, while on the other they try to make do with diminishing resources. And there still remains a vast number of institutional and historical barriers that prevent the field from reaching out to those who need it the most—barriers to leveling the playing field and making education democratically accessible. Malnarich encourages developmental educators to remain resilient and creative in approaches to their work.

What I appreciate most about Malnarich’s tome is the feeling that it is a summary of what you might experience at a roundtable discussion at a conference, and not just the voices of the four contributing writers. Several successful programs lay it out on the table: their developmental education programs, their rationales, their structures, their successes, their failures. The wide range of research from institutions all over the country, balanced between colleges and universities, private and public, large and small, community and clustered, again reflects the possibilities of instituting a developmental education program at any institution. Several of these examples also indicate their programs are “scaled up,” meaning they are used on a very large institutional basis, showing the adaptability of small changes and learning communities. Just as helpful is the exchange of contact information of program directors in an easy-to-access format.

This idea of “small changes” is for me one of the most understated undercurrents evident throughout the monograph, especially as Malnarich’s call for action reiterates the drastic downsizing of services and resources. From smarter assessment to linked courses to team teaching, focusing on small changes has proven successful—in accomplishing the desired changes of increase in retention, persistence, and learning. Yet another undercurrent suggests that perhaps the battles in developmental education do not lie entirely within the institution itself.

Individual state’s legislation often determines the ways in which public secondary education measures success, and therefore determines the levels of student preparedness for college admission. Malnarich assails state legislation that in many ways provides glass ceilings for students or barriers for entrance into colleges for developmental education students, but she spends little time discussing another surprising find—that the connection between school districts and community colleges is an invaluable bridge to build. Some research suggests that this could be one of the most cost-efficient bridges to build. Malnarich cites the example of Alverno College. A key factor is the personal connection between academic advisor and guidance counselor, which results in a better understanding of what the graduating senior expectations are and how to make more of a bridge—or bridge programs—between college and high school. This can increase the chances for success for students who might be considered at-risk.

For most students considered at risk, there are external factors affecting their ability to commit to higher education. Malnarich reviews the inclusion of nontraditional students, defined as returning students and part-time students, as developmental education students, but could provide more depth in the examples showing what may have worked better for each particular group of nontraditional students. Developmental education programs for these students are important considering their increased presence on campuses. Although Malnarich mentions that nontraditional students responded positively to developmental education across the board, there is not a lot of detail into the specific needs of each subgroup—if and how they differ from other developmental students—and what can be done to aid their reentry to school. For instance, for part-time students, linked or paired courses may not be feasible unless they meet during consecutive time slots.

Even less attention is paid to the intense experiences of living-learning communities. Because residential students are in a sense “traditional” college students, while many developmental education students may be commuters with limited economic resources to pay for living on campus or have other demanding life circumstances, living-learning communities may not be possible. I find it hard to imagine that such programs have not been tried. Models focusing on this area are missing from the monograph.

An interesting area for further investigation is the potential link between developmental education cases—as in the case of the university that embeds developmental education into general education courses that are team taught—and the willingness of so-called Millennial students to react positively in group and team settings. Do developmental education students of this generation react differently or more efficiently to developmental approaches? Would these approaches successfully cross into the mainstream if they were enjoyed by all students at varying levels of need?

In conclusion, new professionals to the field will find the monograph useful as an introduction to developmental education and the rationale for their programs. And in the spirit of optimism and possibilities, Malnarich’s positive view of the meaningfulness and necessity of developmental education provides an uplift needed by veterans and newcomers to the field alike, given the increasingly bleak picture of education as painted in the monograph’s call to action.

Book Review

Challenging & Supporting the First-Year Student: A Handbook for Improving the First Year of College.

M. Lee Upcraft, John N. Gardner, Betsy O. Barefoot, & Associates (Eds.). (2005). *Challenging & Supporting the First-Year Student: A Handbook for Improving the First Year of College*. San Francisco: Jossey-Bass.

Reviewed by Norman Stahl, Chairperson and Professor in the Department of Literacy, Northern Illinois University, DeKalb, IL.

In every specialization field in education there is a "go to" text for those professionals who develop the theory, conduct the research, and strive for best practice. For those professionals who focus on postsecondary programs for first-year students, that source for a decade and a half has been the classic text, *The Freshman Year Experience: Helping Students Survive and Succeed in College* (1989), by M. Lee Upcraft, John N. Gardner, and Associates. Indeed, few would argue that this text was not the standard for the First-Year Experience movement.

Yet so much has changed in higher education since the first edition of this text was issued. Even more so, the concerted focus on the first-year student that had bloomed with the birth of the First-Year Experience movement has grown from its infancy into a healthy adolescence. We now find a broadened professional zeitgeist of the experiences and challenges faced by first-year students and the types of institutional programs, services, and courses that promote student success during the incultation to postsecondary education. As pointed out by Upcraft, Gardner, and Barefoot, across the past 15 years there has been growth in the size and scope of first-year programming as well as greater focus on the academic success of first-year students. With this growth there has been increased faculty involvement both in classes and outside of classes, expansion of the field's scholarly and research foundation, and growth of the impact of the assessment movement. There is also a greater focus on the diversity of the first-year student population and an expanding role of technology in students' lives. Indeed, it was due time for the authorship team to revise their seminal work. With the addition of Betsy O. Barefoot to the authorship team, we welcome *Challenging & Supporting the First-Year Student: A Handbook for Improving the First Year of College* (2005) as the new go to text for those working with all facets of the first-year programming.

Challenging & Supporting the First-Year Student: A Handbook for Improving the First Year of College rests on a conceptual framework drawn from the writings of Nevitt Stanford in the 1960s. Stanford theorized that for a student to succeed in academe, there is a fine line that all postsecondary educators must walk between challenging

the student and also supporting that individual. Hence, the audience for the text is an expansive one including administrators from presidents, to provosts, to student services officers, to department chairs as individuals who advocate for or oversee first-year programming on college campuses. The audience further includes practitioners such as the student affairs professionals and the faculty members who work with first-year students on a daily basis in advising centers, learning assistance centers, first-year experience programs, and college classrooms.

This handbook is composed of six parts with 29 chapters written by the three coauthors along with or as well as noted experts (i.e., "the associates") on the various policies, practices, programs, and even politics impacting a student's first-year experience whether it be in a community college or a four-year institution, a private school or a public institution, a school with a diverse population or a school with a targeted student body. Each chapter generally covers not only current research and best practice on the topic but also strives to address issues of diversity and demographics. Each chapter closes with a set of concise recommendations for practice based on the respective chapter's content.

Part One is titled "What We Know About Today's First-Year Students and Institutional Efforts to Help Them Succeed." In Chapter One of the handbook Ishler describes the characteristics and the demographics of today's diverse population of first-year students. This is a well-rounded review of population characteristics that will provide readers with current information as of the time the chapter was authored. Still any reader must understand that such scholarly work becomes historical data almost as soon as it is published. Chapter Two is a review of the research on first-year persistence in college across multiple variables (i.e., student input variables, institutional variables, environmental variables). This work by Ishler and Upcraft also includes coverage of models of student persistence, cautions on interpreting the research, and principles of retention. The chapter provides the reader who is new to the literature on the topic with a firm foundation of topical knowledge, and it provides the more seasoned reader with a comprehensive review of the theory and literature in the field. Part One ends with a chapter by Barefoot that draws upon national survey data to examine how postsecondary institutions are striving to assist first-year students succeed in higher education. The questionnaire design appears to have been comprehensive and the report of the data is presented in a manner that could be considered a rather current status report for the field. To the author's credit, she does point out methodological concerns in the survey process that should be considered in reviewing this work, or any other survey for that matter.

"Recruiting and Challenging First-Year Students" is the title of Part Two of the text. The first chapter authored by Hossler and Anderson delves into the ways an enrollment management program can improve a school's first-year experience for the students. The authors begin with an analysis of key topics (e.g., admissions, enrollment forecasting, retention) followed by discussions of organizational models, current issues, and future trends in enrollment management. Student engagement during the first year of college is the topic of the second chapter in the section. Here Kuh presents an argument that numerous first-year students have an expectations-experience gap that lessens the degree of engagement in their education. He goes on to discuss how the students might become more engaged in the experience and how institutions have a role in promoting

student engagement. The section is rounded out as Schilling and Schilling look at the expectations that first-year students have about the college experience and the disconnect in expectations that faculty and institutions hold for those very students. In addition, these writers cover methods by which faculty and staff might gain information about students' expectations. The strength of Part Two of the text is that it acknowledges that any institutional concern with the first year student cannot simply begin when the individual is well situated in the college experience. Rather there is no clean slate or a postsecondary *tabula rasa* that miraculously evolves between high school graduation and the first-year experience. Indeed, this chapter points to a possible addition for the third edition of the handbook in the years ahead—a chapter detailing partnerships between secondary education and first-year programming.

The third part of book is titled "Creating Campus Cultures for First-Year Student Success." Within this section of the text one finds seven chapters. The first chapter by Hrabowski centers on the critical factors and best practices related to academic performance of first-year underrepresented students of color with emphasis on African Americans, Hispanics, and Native Americans. The author covers issues of holding high expectations for students and avoiding stereotypes as well as institutional commitment, faculty and staff commitment, campus leadership, recruitment, and out-of-class interventions. Jones follows with a discussion of the attitudes about diversity held by first-year students, faculty, administrators, institutions, and the greater public. He further discusses the impact of social class and poverty on access and success of first-year students as well as theory and practice for the reduction of prejudice.

With the third chapter Natalicio and Smith present a case study that discusses the role and commitment of senior administration; the importance of building a comprehensive program based on institutional strengths, values, and core competencies; and multilayered challenges encountered in program design at the University of Texas at El Paso. Siegel next presents the perspectives of a seasoned president of a comprehensive institution. She recommends that senior administrators apply the invitational model to accomplish the leadership and fiscal actions in support of building the first-year philosophy and programs into the institutional mission and culture. Chaskes and Anttonen draw upon personal expertise as well as the literature base to discuss three elements shared by successful advocates for first-year students and programs: (a) a common knowledge base about governance, change theory, time frames, and institutional resources; (b) a set of strategies and tactics including researching, benchmarking, anticipating objections, building coalitions, and developing alternatives; and (c) personal traits honed through years of experience with the governance process.

The theme of the chapter by Schroeder explores characteristics of and barriers to successful partnerships between academic affairs units and student affairs units, strategies for supporting and maintaining relationships, lessons learned through observation of four student success centers, and implications for future partnerships. The section concludes with Junco's overview of the research on technologies used by first-year students, the ways in which technologies impact the population, and the technological disjuncture that may exist between students and faculty. In many ways this is the section that contemporizes the text by focusing on how current issues in higher education (e.g., diversity, leadership, technology, etc.) impact and are impacted by the

first-year movement. The chapters in this section discuss the various questions and concerns that are likely to come forth from senior leadership and campus-wide bodies.

In Part Four we learn about "Challenging and Supporting First-Year Students in the Classrooms." Here we have a section with great breadth of coverage. Each of these nine chapters covers a specific topic (academic approaches and services) on how institutions can promote the academic success of a diverse body of first-year students. In all likelihood this is the section that readers from academic programs will go to initially to read about their respective areas of practice or research.

In the first chapter Erickson and Strommer discuss the factors that impact the academic achievement in the classroom including academic preparation, motivation for learning, learning styles, and stages of intellectual development. In addition, the authors put forth a conceptual model of pedagogy along with recommended instructional methods: small group discussion, writing to learn activities, case study approaches, problem-based learning, and experiential learning. Next Evenback and Jackson examine the challenges faculty will face in working with first-year students, the rich opportunities for professional growth presented for faculty through such endeavors, and the directions for faculty development programming, which is expanded through case studies. Hunter and Linder then provide a thorough coverage of the first-year seminar including a definition and a rationale, a brief history of the movement, a description of standard models, recent trends and issues that have come to light through national surveys, the relationship of such seminars to other first-year programs, and the evidence of the effectiveness of such seminars.

The section continues with a chapter by Higbee on developmental education that examines the mission, theory, and significant research underlying developmental education, the nature of the students served by these programs, and selected models of developmental education programs. Next Martin and Hurley discuss (a) Supplemental Instruction's theoretical underpinnings, (b) the evidence of its effectiveness, and (c) the technology-enhanced model or Video-based Supplemental Instruction (VSI). King and Kerr put forth seven models of academic advising by examining the organization and the delivery of first-year advising programs, the components of effective programs, the growing use of technology, and the approaches for serving a diverse clientele. Watts then provides a discussion on the ever-evolving role of the library on the 21st century college campus along with sage guidance on how and why the first-year student should become information literate. Zlotkowski presents the theoretical constructs of service learning and the practical benefits for the new student from the convergence of the service learning movement and the first-year student movement. The coverage of programs serving first-year students in academic milieu is rounded out with Laufgraben's coverage of the characteristics of learning communities through five general models, and guidelines for the implementation for successful programs.

As already noted, this section contains great breath in coverage of topics. Each chapter is a thorough overview of the topic being addressed. Still each is but an overview of theory, selected research, and practice; each topic is expansive enough to have monographs and texts written about it. The strength of this section may be that it will serve that individual using the section or a particular chapter as a handbook style

reference source with information to more fully examine the type of program or service of interest.

Based on the premise that success in the first year of postsecondary education is influenced by factors well beyond the academic dimension, Part Five of the text focuses on "Challenging and Supporting First-Year Students Outside the Classroom." Mullendore and Banhan cover the design of orientation programs with attention to national standards, the mission and goals of programs serving varied populations, procedures for assessment and evaluation, and current trends in orientation practices. Living environments, both on-campus and off-campus, for first-year students are examined in the chapter by Zeller. Specific attention is given to trends in residential hall design, master plans, lifestyle orientations, and program initiatives, along with programming for off-campus residents. In the next chapter Schuh begins with a conceptual framework for student affairs and then discusses how programming from a range of services not covered in depth in other sections of the handbook can play an important role in promoting success for first-year students (e.g., counseling services, student health programs, college unions). Meilman and Presley complete the section by reviewing research on alcohol and drug use and abuse on campus, the reasons for drinking by first-year students, and prevention strategies and outreach programs.

With Part Five of the handbook those academics and administrators who view student services programming to be tangential or at best a less significant part of the academic experience are presented a comprehensive discussion of the value of such programs. The greatest issue will be how to get academics to read this particular section of the handbook in that such handbooks often take on a role of the readily available reference source for targeted referral and reading. Perusal of this section by academics will go a long way to bridge the artificial divide that exists on so many campuses between the academic affairs division and the student services unit for not only the first-year program but also the entire undergraduate experience.

Part Six, titled "Assessing the First College Year," demonstrates the convergence of the postsecondary assessment movement with first-year programming. The section begins with a chapter by Upcraft providing a set of definitions from the assessment field, a rationale for undertaking assessment, a comprehensive model of assessment for the first year of postsecondary education, a discussion of obstacles to assessment activities, and finally a section on the ethics of assessment. With the next chapter Upcraft and colleagues Ishler and Swing present a beginner's guide to an 11-step assessment process as well as a three-step outcomes assessment process for assisting colleges in developing comprehensive assessment programs. In the last chapter in this section of the handbook, Swing and Upcraft cover the selection and description of instruments, both quantitative and qualitative, used in the assessment processes.

Part Six clearly brings to the forefront the importance of the assessment movement for the first-year program given that it often sits on an accountability bubble in the eyes of ever so many of the stakeholders in higher education. The individual charged with designing and evaluating first-year programming will find a valuable overview of assessment policies, procedures, practices, and protocols in this section. Still, while the chapters focus adequately on assessment, there is but passing discussion of the fields

of evaluation and research. The individual interested in either formative or summative evaluation or in traditional research endeavors will need to consult other reference or methodological sources.

The authors complete the text with a conclusion in which they detail principles of good practice for the first year of postsecondary education, followed by a summary of well-crafted recommendations that can assist institutions in developing an integrated, comprehensive approach to challenging and supporting students so as to permit them to reach their academic and personal goals. Finally, the authors look to the future by highlighting challenges that will be faced by the field.

It was noted in the first paragraphs of this review that *Challenging and Supporting the First-Year Student* is the go to text for the current generation of postsecondary educators who strive to promote the academic and personal successes for a diverse population of students new to higher education. There is no doubt that this handbook contains great breadth of coverage of topics important to the first-year student movement. Indeed, Upcraft, Gardner, and Barefoot could not have taken greater care in the selection of the chapter topics or authors. It is clear that the mission of the text is to describe the greater milieu and then to cover myriad programs, services, courses, and initiatives designed to lead students to make the successful transition and acclimation to college. Furthermore, the chapter authors are either acknowledged leaders in their respective fields or individuals able to provide unique and interesting perspectives given their leadership positions in higher education. If the fundamental goal of the text was to achieve breadth of topic that defines and perhaps even unites a field, the authors have achieved this goal brilliantly.

It was also noted in the first paragraphs of this review that the movement is in a stage of healthy adolescence. As such the practitioners in the movement are at the stage where the development of programs, the planning of academic classes and support services, the design of extracurricular experiences, and so on, should be based on sound research. Here is where this handbook does not always stand up to expectations one holds for the current generation of handbooks addressing issues of pedagogy. Such may be viewed as a growing pain of sorts.

There are chapters within this work where the authors, or associates, build their respective arguments from higher education theory and philosophy, personal experience within localized contexts, perceived best practice, recommendations of accepted authorities, and even silver-standard (i.e., correlational, etc.) and bronze-standard (i.e., qualitative) research. We see the authors draw heavily and perhaps too regularly upon a set of seminal studies, texts, and articles by noted authorities such as Sax, Tinto, Pascarella, and Terenzini. Although such information is informative and provides an understanding of the state of the art, the research and the personal philosophies used to build cases or make recommendations more often than not do not rest on a foundation of gold-standard empirical studies with acceptable designs with randomized trials and appropriate statistical procedures. Five years ago this situation would not have been a particularly important issue in the field. Yet, given the changes in educational policy at the federal level and often at state levels as well, such research is now of major importance.

Still, taking such a stance so as to point out a weakness in some chapters in a text may be somewhat unfair, as you cannot draw upon something that does not exist to any great degree. The field of higher education, far more than in the prekindergarten through secondary school milieu, suffers from a dearth of quality gold-standard research upon which to design or develop programs, services, and academic experiences. Such a situation is compounded as whenever there is a field that has a conscience, and if it is based on the greater good for the first-year student, it will likely have great difficulty in accepting the parameters of a research model that calls for experimental controls and randomization that will deny services by design. Hence, many forms of programming for first-year students have had difficulty in demonstrating that they stand on a research-driven footing as the tenets of gold-standard research and the tenets of student-oriented programming more often than not are diametrically opposed to each other.

A handbook by practice and by heritage must reflect depth as well as breadth of coverage. Depth should be drawn from quality research on each of the many topics found in the work. This position leads to a question of whether this text has an acceptable level of depth. The answer is a qualified "yes." There is no doubt that this handbook reflects the state of the art. However, with the recent pressures to once again embrace well-designed quantitative models of research and to build practice upon the findings of such work, this field that was coming into its own during the qualitative revolution and the emergence of the assessment movement has a foundation that needs shoring up by today's standards.

This is not to say that qualitative research, assessment findings, philosophical positions, or contextualized best practice reports should be abandoned, as such would promote the same shortsightedness that was encountered with the abandonment of quantitative research during the qualitative revolution. What is noted here and what is demonstrated by this comprehensive text on the first-year movement is that as the new generations take over the mantle of leadership in the field and as the field reaches its maturity, those leaders must undertake a greater degree of acceptable quantitative research followed by well-crafted meta-analyses of the fields many constituent parts as have been undertaken in other fields of pedagogy. Such, in a sense, becomes the recommendation for the third edition of this text. Hopefully, it will not be so long between the development of handbooks in the future.

In closing, *Challenging & Supporting the First-Year Student: A Handbook for Improving the First Year of College* is a well-designed text that should be read by all individuals associated with students new to the college environment. It serves as a reference, but it will not reach its full potential in your hands if only used as a reference. It presents an all-encompassing philosophy for higher education, a concrete review of the state of the art, and a roadmap for future research in the field. It belongs on the bookshelf of any educator concerned with excellence in postsecondary education.

Call for Manuscripts: The Learning Assistance Review

Statement of purpose

As an official publication of the National College Learning Center Association (NCLCA), *The Learning Assistance Review* seeks to foster communication among learning center professionals. Its audience includes learning center administrators, teaching staff, and tutors, as well as other faculty members and administrators who are interested in improving the learning skills of postsecondary students. *The Learning Assistance Review* is available free of charge to all NCLCA members. The library or institutional subscription rate is \$25.00.

The Learning Assistance Review aims to publish scholarly articles and reviews that address issues of interest to a broad range of academic professionals. Primary consideration will be given to articles about program design and evaluation, classroom-based research, the application of theory and research to practice, innovative teaching and tutoring strategies, student assessment, and other topics that bridge gaps within our diverse profession.

The journal is published twice a year, in the spring and fall. The co-editors are issuing this call for manuscripts to all learning professionals who are interested in contributing to the field through the publication of relevant, scholarly articles. All submissions are subject to a masked review process.

Manuscripts will be forwarded to the editorial board for masked peer review. Authors will then be notified regarding the status of their articles and will receive recommendations and feedback in a timely manner.

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TLAR is the official journal of the National College Learning Center Association (NCLCA). You, given the changes in institutional policies at the National Learning Center Association (NCLCA), are encouraged to submit your work to TLAR.

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NCLCA Membership Information

What is NCLCA?

The National College Learning Center Association (NCLCA) is an organization of professionals dedicated to promoting excellence among learning center personnel. The organization began in 1985 as the Midwest College Learning Center Association (MCLCA) and "went national" in 1999, changing the name to the National College Learning Center Association (NCLCA), to better represent its nationwide and Canadian membership. NCLCA welcomes any individual interested in assisting college and university students along the road to academic success.

NCLCA defines a learning center as a place where students can be taught to become more efficient and effective learners. Learning Center services may include tutoring, mentoring, Supplemental Instruction, academic and skill-building labs, computer-aided instruction, success seminars and programs, advising, and more.

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NCLCA seeks to involve as many learning center professionals as possible in achieving its objectives and meeting our mutual needs. Therefore, the NCLCA Executive Board invites you to become a member of the Association.

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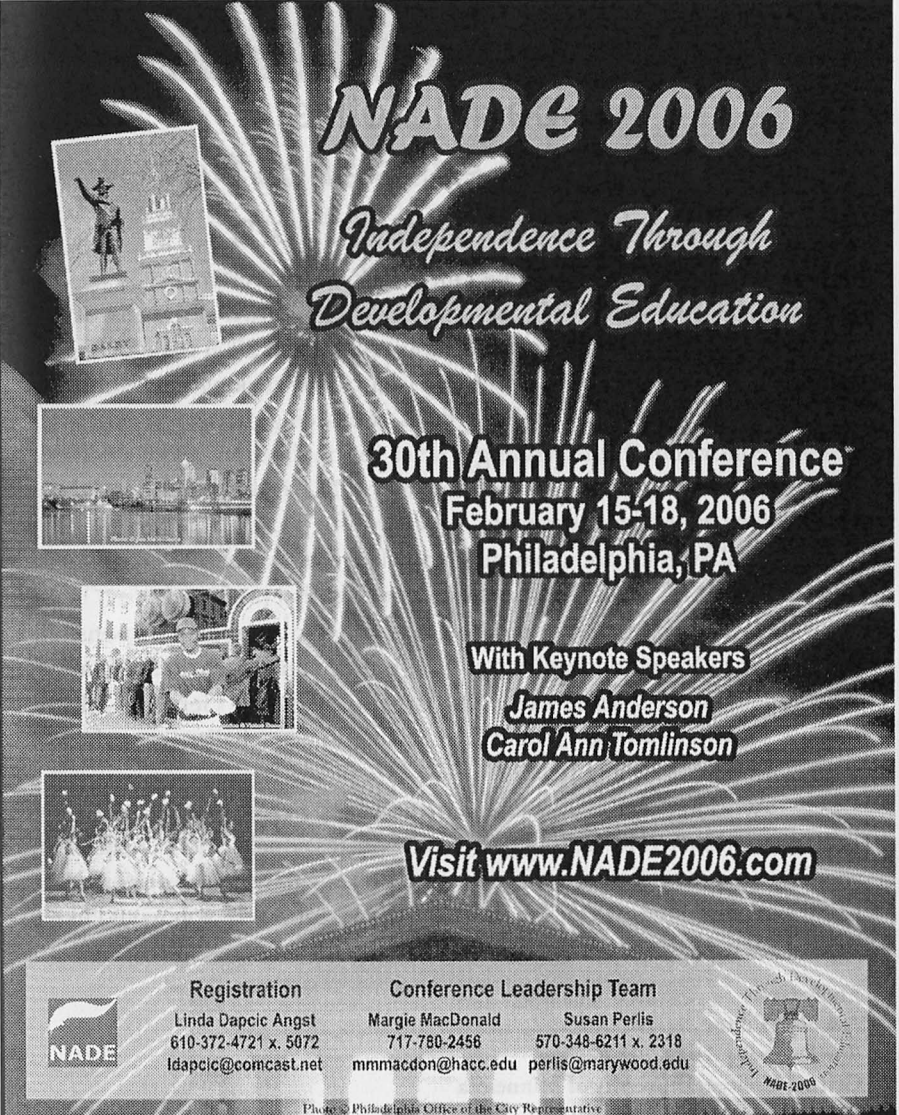
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The Learning Assistance Review

The Journal of the National College Learning Center Association

Special Notice: The Learning Assistance Review Seeks New Editors

Jeanne Higbee and Irene Duranczyk, current editors of *The Learning Assistance Review* (TLAR), will be stepping down at the end of their 3-year term, effective with the publication of the fall 2006 issue of the journal. The NCLCA Executive Board is currently seeking new editors. Responsibilities include soliciting articles, overseeing the review process, making editorial decisions, editing articles for publication, and coordinating all aspects of layout, printing, and mailing of TLAR. Qualified candidates should have experience serving as a reviewer for TLAR or other professional journals and a working knowledge of American Psychological Association (APA) style. Editorial experience is also preferred.

It is hoped that there will be a period of overlapping responsibility between the old and new editors so that Jeanne and Irene can assist in providing mentoring as needed. With the closure of the General College in June 2006, Jeanne and Irene will be taking on new challenges at the University of Minnesota next fall.

Working on the journal is a great way to hear about the innovative research conducted by learning assistance professionals, and to help shape the field as well. All of this pleasure and power can now be yours if you bring the editorship of our journal to your institution. If you would like to be considered, please contact:

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