Evaluation Theory for Developmental Mathematics Practitioners

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This article is designed to present an overview of critical theory, research, and evaluation for the developmental mathematics educator. Students caught in the gap between high school mathematics preparation and entry-level college mathematics expectations — developmental mathematics education students—need to have their personal narratives told and have the measures of success reflect their needs. Highlights of evaluation theory and research, as well as a combination of qualitative and quantitative methods are presented for the developmental mathematics classroom researcher. There is an ongoing need for practical information on the effectiveness of programs and services addressing the mathematics educational gap. Hopefully this article will help you define your role in advancing this important evaluation and research area.

Whenever college populations are expanding and financial resources are diminishing, the role of developmental education is questioned (Saxon & Boylan, 1999). Many studies have demonstrated the effectiveness of developmental education through a variety of research methods (Boylan, Bliss, & Bonham, 1997; Boylan, Bonham, Claxton, & Bliss, 1992; Roueche & Roueche, 1993; Thomas & Higbee, 1996; Waycaster, 2001), especially in terms of student retention (Durant, 1992; Lyons, 1990; Simmons, 1994; Umoh, Eddy, & Spaulding, 1994). Politically, this research has not been reason enough for higher education to embrace developmental education, particularly at 4-year colleges and research universities (Jenkins & Boswell, 2002). This article will outline the history and benefits of three research areas (outcomes theory, retention theory, and attribution theory) that can assist developmental mathematics education practitioners in determining

what data will assist in program evaluation and will capture the benefits of developmental mathematics education for individuals who have completed their secondary education successfully and are deemed underprepared for postsecondary educational services.

Outcomes Theory and Research

In each decade since 1960, at least one outstanding outcomes theorist in the evolution of evaluation theory stands out (Fink, 1995; Lancy, 1993; Shadish, Cook, & Leviton, 1991). Social program evaluation theories emphasized a search for truth about effective solutions to social problems in the 1960s. Although Scriven (1983) and Campbell (1963) exemplify this period, the controversial work of Scriven on unanticipated outcomes or needs-referenced evaluation particularly highlights capturing the student's voice. "Programs, like products, should be evaluated by matching their effects against the needs of those whom they affect" (Scriven, p. 235). Scriven's model for evaluation called for an outside evaluator who would not reference program goals prior to data collection—who would evaluate the program solely based on participant perceptions—without prior institutional or political program knowledge.

In the 1970s, Stake added the concerns of how social science concepts and findings could produce political and socially useful results (Shadish et al., 1991). In this vein, Stake advocated qualitative methods for social program evaluation and emphasized the role of the case study in evaluation to find useful input-output relationships. Stake, like Scriven (1983), did not emphasize management concerns. Underlying Stake's approach, however, is "concern for stakeholder well-being, identification of the particular stakes that persons have in a program and a desire to serve those whom the program is supposed to be helping" (Shadish et al., p. 273).

In the 1980s, Cronbach and Rossi (Payne, 1994) stand out. Both placed greater emphasis on evaluation to facilitate the transfer of knowledge for social program improvement throughout the U.S. The voices of all stakeholders are of equal value. Cronbach advocated the use of quantitative social research, history, ethnography, journalism, and critical reflection as evaluative research methods.

Outcomes theory and research was used primarily to evaluate social programs, not educational programs. Quantitative research dominated educational research. Numerous quantitative studies have indicated that educational and social programs did not have significant outcomes. In response to this trend, Patton (1990) advocated the use of case studies:

> Case studies are manageable, and it is more desirable to have a few carefully done case studies with results one can trust than to aim for large, probabilistic samples with results that are dubious because of the multitude of technical, logistic, and management problems. (p. 100)

Patton said that most program evaluation is based on the false premise that educational interventions are true experiments, when, in fact, uneven implementation of programs, self-interest of participants, and difficulty of specifying—let alone measuring—outcomes makes it too easy and too likely to explain away or ignore negative results. Qualitative research, relatively open ended and concerned with how as well as how well, can much more honestly depict contextual factors.

Through the work of Freire and Faundez (1989), Stage (1992), and Stage, Muller, Kinzie, and Simmons (1998), research in higher education has moved into critical research. Stage (1992) urged

> researcher[s] to move beyond explanation of what is happening today and focus research toward attempts to influence future possibilities. This perspective, critical theory, may be helpful to those seeking new ways to gather data on their campuses to effect change in those environments. (p. 2)

This philosophy has provided the foundation for current practice in evaluation in higher education.

Retention Theory and Research

One area of evaluation that continues to be a high priority for postsecondary institutions is the study of student retention. Tinto developed an interaction theory model that contends that retention or attrition results from the holistic interactions between a student and the collegiate environment and not solely from individual attributes, program components, or the environment. Tinto's model has driven much of the retention research and has been used by a number of

developmental education researchers to measure student persistence (Nora, Attinasi, & Matonak, 1990). Nora et al. contended, "Student persistence studies have not found that precollege factors have a significant impact on retention, but this lack of extensive direct effects may result from misspecification errors because studies have not incorporated appropriate indicators in quantitative models" (p. 338). The researchers hypothesized that getting ready for college would be a significant precollege indicator of persistence. This quantitative study, however, revealed that getting ready for college actually had a negative direct effect on retention.

Reflecting on Patton's (1990) evaluation of narrow-focused, quantitative studies suggests that a more exploratory study, using qualitative methods, might discover why students persist, even if they are underprepared, have histories of failure, or are identified as developmental education students. Would qualitative research on nontraditional students also indicate that precollege getting-ready experiences have a negative impact on retention? "There is only so much of human behavior that can ultimately be captured in numbers. The researcher needs to ground his or her understanding of what happens to students in college in the students' own understanding of these events" (Attinasi & Nora, 1992, p. 25).

Tinto's (1993) model has also been used to predict success. A critical ethnographic study seeking to understand why and how developmental education students persist may provide more insight into underprepared college student retention. Certainly, factors of adult motivation may be significant in predicting or promoting the success of nontraditional students. Studies by Umoh, Eddy, and Spaulding (1994) and Whiteley and Fenske (1990) added further uncertainty to the topic when they used the Tinto model with post-secondary developmental mathematics students.

Whiteley and Fenske (1990) conducted a longitudinal study examining ways in which college mathematics influences stability and changes in students' final choice of undergraduate majors. The independent variables were mathematics exposure, high school grade point average (GPA), college GPA, gender, race and ethnicity, ACT mathematics score, college mathematics experience, non-mathematics

academic experience, and shift to final major. Whiteley and Fenske concluded that a complex relationship existed:

> The interaction of the college mathematics experience with both the student and the institution are complex and should not be oversimplified across college majors and/or student preparation levels…. Our findings strongly suggest that it is time for researchers and policy makers to move away from the simplistic and now outdated notion of mathematics as the "critical filter" and toward a new focus on research and thinking about college mathematics. (p. 382)

Umoh et al. (1994) examined the relationship between retention of students in 2-year developmental mathematics programs and several variables: age, gender, parents' education, GPA, academic goal commitment, academic integration, institutional experience, placement test scores, and student performance. They found no statistically significant relationships between the independent variables and retention of developmental mathematics students. However, they did make the following comment:

> Developmental education students differ from typical college or university students because neither grade point average nor academic achievements are factors in determining retention in developmental education mathematics programs. Students taking developmental education mathematics are not forced out. Retention in developmental education mathematics seems, therefore, to be based on an individual student's intent to continue his or her studies, irrespective of getting good grades. (p. 42)

Attribution Theory and Research

Another important area of research related to understanding student trends in developmental mathematics, yet quite limited in scope, is attribution theory research. This body of research has focused on the Adult Mathematics Attribution Scale (AMAS) by Lehmann (1987) and the Mathematics Attribution Scale (MAS) developed earlier by Fennema, Wolleat, and Pedro (1979). These instruments isolate attribution of success and failure to ability, task difficulty, effort, or luck. The study by Lehmann included nontraditional students and found neither significant difference in characteristics (attribution of success and failure or pre-post course measures) of traditional and nontraditional college freshmen taking a developmental mathematics

class nor a significant correlation between attribution and pre- or post-course measures.

Bempechat, Nakkula, and Wu (1996) used attribution theory as a predictor of mathematics achievement. They asked the question, "Do high and low achievers differ in their attribution patterns, and if so how?" (p. 54). Studying sixth graders, they concluded that high achievement was associated with attributing success to ability. There were a few more studies in the last 20 years attempting to relate attribution and achievement in mathematics students at the college level using the MAS and AMAS scales.

Dependent Variables Informing Educational Research

Penny and White (1998) conducted an ex post facto multiple regression analysis of selective characteristics of developmental faculty (gender, age, educational preparation, teaching experience, and employment status) and students (gender, ethnicity, age, and enrollment status) to determine which attributes are significantly related to student performance in developmental mathematics and their subsequent college-level algebra course. Their study revealed that students' performance in the last developmental mathematics course was the strongest predictor of their performance in college algebra. The study also revealed that part-time enrollment and traditional college age had a negative effect on student performance. The impact of age on performance was not supported in the research conducted by Burgess (1992). In that study, younger students performed better in all levels of mathematics than nontraditional age students.

These studies, along with quantitative studies conducted by Durant (1992), England (1993), Feingold (1994), Lyons (1990), Seybert and Soltz (1992), and Short (1996), identified characteristics of developmental education students that affected their performance or predicted success. The question that remains unanswered is: Why do these characteristics have an impact on success? A qualitative study can shed light on the findings of quantitative studies. Qualitative studies provide the thick descriptions needed to understand the connections between student characteristics and performance. Qualitative studies can reveal and discover other characteristics that may be significant or underlie the characteristics revealed in quantitative studies (Eisner

& Peshkin, 1990). The impact of developmental education is a complex field of study which will not be understood using any single methodological approach. This article does not have answers but raises qualitative questions for the practitioner to ponder and then proceed to design a research study which will "render tone, tint, texture, and nuance" to quantitative approaches which provide only the "broad outlines of the portrait" (Pascarella & Terenzini, 2006).

Conclusion

There is much more evaluation work that can and must be done to make the case for developmental mathematics education and its benefits to society, institutions of higher education, and all postsecondary students. American College Testing (ACT, 2005) reported that only 41 percent of the high school graduates who took that ACT in 2005 scored a 22 or higher on the ACT Math Test, indicating they had a high probability of succeeding in college algebra. That leaves 59 percent of the high school graduates in 2005 demonstrating less than college level skills on the ACT Math Test and possible candidates for developmental mathematics course work. The number of students underprepared in mathematics seeking postsecondary options will continue. How will we address this need? How will we present the effectiveness of our developmental mathematics education components and programs? Hopefully the research methods presented in this article will help you think about new approaches and possibilities for evaluating developmental mathematics programs.

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