



Mentoring Minority Students in Biomedical Engineering: An Engaged Approach

Dr. Christine S Grant, North Carolina State University

Dr. Tuere Bowles, NC State University

Dr. Tuere A. Bowles is an Associate Professor in the department of Leadership, Policy, Adult and Higher Education. Professor Bowles' research specializes in: adult learning and development, equity issues in education (race, ethnicity, gender and social class), assessment, workforce development and women's learning and development. She received her B.A. in English at Spelman College, an M.Div. in the ITC/Morehouse School of Religion and a Ph.D. in Adult Education at the University of Georgia.

Mrs. Olgha B Davis, North Carolina State University

Mrs. Davis earned her BS degree in Biomedical Engineering from Boston University and MS degree in Biomedical Engineering from North Carolina State University (NCSU) and UNC Chapel Hill. Currently, Mrs. Davis is the education coordinator for the BioMed-Connect Mentoring Incubator at NCSU College of Engineering. Mrs. Davis main responsibilities include conducting research and writing grant proposals and final reports, developing the educational curriculum for the mentoring program, and facilitating weekly laboratory group meetings, and organizing professional development seminars for the participants. Mrs. Davis also is a doctoral students at the Adult Education program at NCSU.

Dr. Rex E Jeffries, North Carolina State University

Ms. Barbara Smith, North Carolina State University

Mentoring Minority Students in Biomedical Engineering: An Engaged Approach

Abstract

There is a compelling need for a program that develops self-efficacy in Underrepresented Minority (URM) students in STEM related fields. To answer this need, a professor and lifelong mentor developed the national mentored-leadership initiative program to empower URM students at the high school and undergraduate levels in their successful pursuit of engineering careers. This objective is accomplished by actively partnering students with senior URM mentors (i.e. post-doctoral associates and faculty members) in research and professional development. Students that completed the program more likely have a firm understanding of the translational aspects of their research, enabling them to make informed career choices to maximize their expertise and biomedical interests. Ultimately, this outcome can be achieved through engaged participation in: a “mentoring incubator” and mentoring course led by URM full professor; interactive seminars and roundtable discussions with mentee “success story” resource group; sessions with biomedical group of successful URM engineering faculty; and targeted research experiences at a large research university, leveraging partnerships with agency-sponsored programs.

1. Introduction

The purpose of this work is to present the program and evaluation design for an existing mentoring research program for underrepresented students at North Carolina State University. The BioMed-Connect Alliance (BMCA) initiative was established in 2011 by Professor Christine Grant as a pilot program to target Underrepresented Minority (URM) students at various academic levels to further enhance their understanding of the translational aspects of research and educational activities to express informed career choices to maximize their experiences in Biomedical Engineering. This work consists of the program description that is followed by a needs assessment, logic model, evaluation implementation and process, output design overview, stakeholders and evaluation results dissemination, and lastly a summative conclusion for this approach.

2. Program Description

The BMCA program is designed to empower students at K-12 to K-20 levels in their successful pursuit of Biomedical Engineering careers by actively engaging senior Underrepresented Minority (URM) mentors such as alumni, postdoctoral associates and faculty members in experimental research and professional development. Students completing the BMCA will have a firm understanding of the translational aspects of their research, enabling them to make informed career choices to maximize their expertise and Biomedical Engineering interests. This outcome will occur through engaged participation in: (i) interactive laboratory

weekly meetings with mentors and mentees to discuss weekly progress of research and roundtable discussions with the “Mentee Success Alumni Resource Group”; (ii) targeted research experiences at North Carolina State University (NCSU) (leveraging a partnership with the NCSU NIH sponsored IMSD Program) and eventually with faculty partner at other institutions in the summer months (e.g., Caltech, MIT, GA Tech, Berkeley); and (iii) interactions with faculty performing biomedical research at all levels in this medical issue – from the cellular level to the patient level.

The “mentoring incubator” concept uses as a framework the Principal Investigator’s (PI’s) own mentoring network which includes members of the National Academies, department heads, leading researchers, career development coaches and former students. Through a series of experiential dialogues, one-on-one mentoring and engagement with Grant, her mentors and accomplished mentees, students will develop specific skills for successful biomedical careers. As founder and director of the PURPOSE Institute for Minority Faculty Development, the PI also has a strong network of active underrepresented minority STEM faculty. This established peer mentoring network was utilized as a starting point for identification and connection to a distinguished set of research faculty for potential undergraduate, graduate and postdoctoral research opportunities.

3. Program Needs Assessment

Over the past three decades, the social, educational and economic outcomes for African-American males have been more systemically devastating than the outcomes for any other group, such as race, ethnicity, or gender group¹. In 2009/10, the national high school graduation rate for African-American male students was 52%. While the graduation rate for Caucasian males students was 78%. African-American males have consistently low educational attainment levels, are more chronically unemployed and underemployed, are less healthy and have access to fewer health care resources, die much younger, and are many times more likely to be sent to jail for periods significantly longer than males of other racial and ethnic groups. On average, African-American males are more likely to attend the most segregated and least resourced public schools. However, in most states, the stratification of school quality works to minimize educational opportunities specifically for African-American students¹.

Despite the slight variation in high school graduation rates in North Carolina (African-American male at 58% and 71% for Caucasian males students), there is still a noticeable graduation gap of 13% between African-American and Caucasian male students¹. The information is not much better for Wake County, North Carolina, the location of NCSU. African-American male students were classified as Gifted/Talented less than one-sixth as often as Caucasian male students in the Wake County public schools and were five times as often placed in Mental Retardation classifications. If African-American male student had been admitted to Gifted/Talent programs at the same rate as Caucasian male students, at least an additional 3,000 would have had that opportunity. Proportionate to enrollment, more than eight

times as many male Caucasian students as male African-American students in the Wake County public schools in 2004/5 were allowed to participate in Mathematics Advanced Placement courses and more than six times as many in Science Advanced Placement courses. On the flip side, the numbers of African-American males in both engineering and sports is woefully disproportionate to their presence in the population of the United States. In 2012, African-American males made up 4% of the currently enrolled male students in engineering according to the National Science Foundation (2012)¹.

While the above statistics are focused on African-American males, there are similar disparities in the educational achievement gap for other URM students; this project will impact a cross section of students. One survey noted that 40% of underrepresented STEM professionals report that they have been subjected to discouragement throughout their STEM career; indicating a critical need for mentoring². Only 18.5% of Black college students and 17.3% of Hispanic college students plan on pursuing a STEM major, according to a study by the Higher Education Research Institute at UCLA. Unfortunately, only 25% of underrepresented students who declare a STEM major earn undergraduate degrees in STEM, compared to 50% for all undergraduate students. African-American and Hispanic students are more than twice as likely to switch to other majors as Caucasian and Asian students. In light of all of the challenges in the economy and the movement of jobs overseas, the preparation of these young men and women for careers in technology is essential for our city, state and nation to utilize the talents of all of its citizens effectively. This work will focus on the evaluation design of this project. The BMCA project focuses on the creation of a set of educational materials grown out of “hands –on” laboratory and research experiences, interactive interviews and cutting edge informational technology. The creators of this content, URM students educated in North Carolina; will form the network of role models for future generations of STEM students.

4. Program Logic Model

A program theory should guide the evaluation process of any given program. Evaluators often use logic models to analyze the theory behind the programs that they are evaluating. Logic models can be used as tools to identify key evaluation questions and to allow stakeholder buy-in from the beginning of the evaluation process by assisting in clarification on how the program works^{4,5}. In addition to identifying questions and early stakeholder buy-in, logic models can be used as graphical representations of the relationships among important components of the prescribed programs. These key elements consist of inputs, activities/processes, outputs, outcomes, and impacts of the projects and often lead to increased quality, the efficiencies of the program, and the effectiveness of the evaluation processes^{4,5}.

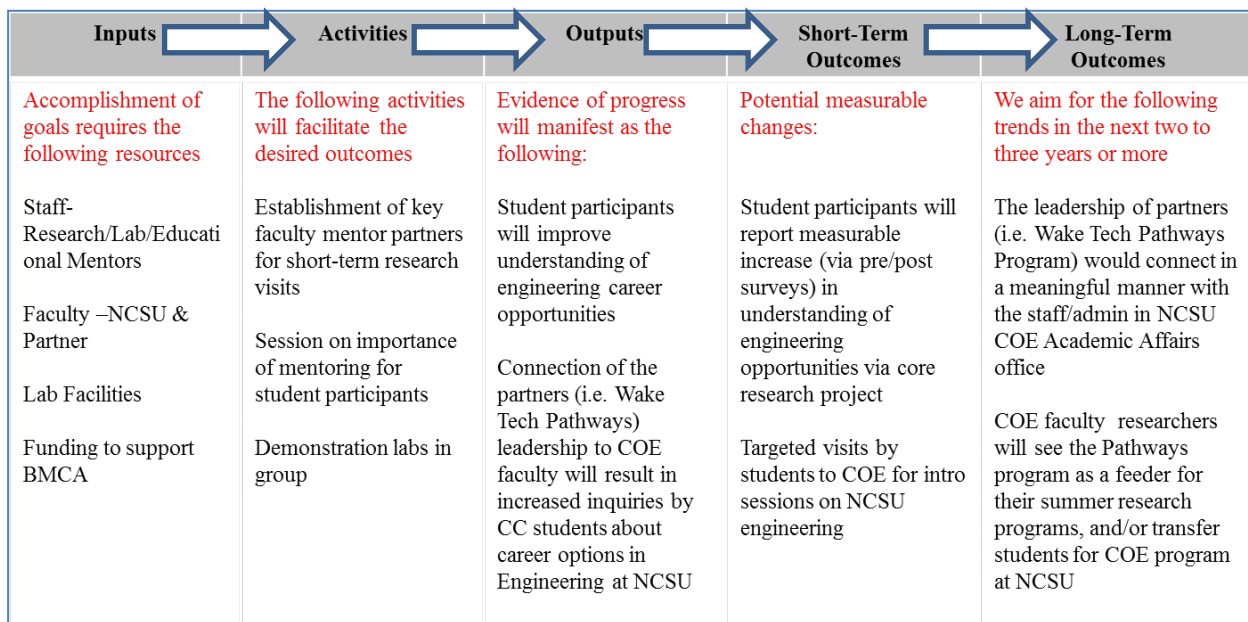


Figure 1: Logic Model for BMCA Program

In this evaluation design, the inputs to the logic model, presented in Figure 1, consist of the available resources that are necessary to run the intervention program, such as staff and faculty members, partners, laboratory facilities and equipment, and funding agency. The NCSU staff consists of a college of engineering (COE) Assistant Director of Faculty Development and Special Initiatives, Barbara Smith (personnel and budgeting mentor), a biomedical engineering (BME) post-doctoral associate, Rex Jeffries (lab mentor and research coordinator), an adult education Associate Professor, Tuere Bowles (mentor), and an Adult Education doctoral student with a Master’s degree in BME, Olgha Davis (educational coordinator, mentor, and evaluator). The NCSU faculty consists of chemical & biomolecular engineering Professor Christine Grant and BME professor Michael Gamcsik who are in charge of two cell culture laboratories located on the NCSU Centennial campus in the Engineering Building III, the newest building in COE. The current partnership is with the Wake Technical Community College Pathways 3M Male Mentoring Program for minority students. The program coordinator of the Pathways program, William Kincy, refers up to four interested Wake Technical Community College (WTCC) students to the BMCA program per year. This collaborative community college program is currently funded through a 2012/2013 Extension and Engagement grant from NCSU that serves as a seed grant initiate this pilot program.

With the appropriate resources available and in place, the program can then conduct specific recurring activities and processes to ensure the outcome of the desired goals. These activities include the establishment of key faculty mentor partners for short-term research visits. Currently, Professors Grant and Gamcsik from the COE, and Professor Bowles from the Leadership Policy Analysis and Higher Education (LPAHE) Department and Dr. Jeffries (post-doctoral associate) from BME. These key mentors craft out manageable research projects that the WTCC students can participate in and produce valuable results as part of their mentoring

experience. In addition, weekly lab meetings take place to illustrate the importance of mentoring for students at all levels. In addition to lab experiences and participating in lab meetings, the participants (WTCC students) visit various engineering labs at NCSU centennial campus to see the different aspects of engineering projects and empower the students to make informative academic and career choices in this field.

With adequate resources and recurring activities and processes for the BMCA program, this program can be evaluated and seen as accountable in the public eye. Its accountability can be seen through its outputs that potentially can manifest in terms of increased community college student participants' interest and understanding of the possibilities of careers in the engineering and technology. Outputs of this program can also be observed through the connection of the partners between NCSU and WTCC Pathways 3M program which more likely lead to increased inquiries by community college students about the career options available in engineering at NCSU.

The short-term outcome can be measured through pre- and post- surveys that target the student participants' understandings of engineering opportunities from the assigned core laboratory research projects and the targeted laboratory visits of other engineering facilities at NCSU. The long-term outcome changes within two to three years, will eventually lead to greater impact, a meaningful network and enabling relationships to develop between WTCC Pathways staff and NCSU stakeholders. In addition, we foresee that NCSU COE faculty researchers will connect with the WTCC Pathways program as a mechanism for providing summer internship and undergraduate research programs, and facilitating the ease of transfer of the WTCC student participants into the COE program at NCSU.

It is important that the logic model of any program that is being evaluated is clearly designed and described as above, because it drives the evaluation questions.

3. Evaluation Implementation and Process

In theory, the evaluation implementation and process is straightforward if the evaluator systematically follows the prescribed logic model. In practice, however, the implementation and process of the evaluation is not that simple to bring forth. As specified in the evaluation literature⁵:

To be effective in bringing about the desired improvements in social conditions, a program needs more than a good plan of attack. Most important, the program must implement its plan; that is, it must actually carry out its intended functions in the intended way. Although implementing a program concept may seem straightforward, in practice is often very difficult. Social programs typically must contend with many adverse influences that can compromise even well-intentioned attempts to conduct program business appropriately. The result can easily be substantial discrepancies between the program as intended and the program as actually implemented. The implementation of a

program is reflected in concrete form in the program processes that it puts in place. An important evaluation function, therefore, is to assess the adequacy of program process: the program activities that actually take place and the services that are actually delivered in routine program operation (p. 170).

In this work, the BMCA program fidelity is addressed by using onsite observations and a clear program description of program execution and delivery. In addition, empowerment evaluation approach is used throughout the evaluation process. Empowerment evaluation was coined by David Fetterman in the early 1990s. This approach seems appropriate to this type of program since it places a great emphasis on empowering evaluation processes and program effects and utilizes concepts, techniques, and findings from evaluations in order to nurture improvement and self-determination of the stakeholders^{5,6}. This approach is dynamic and evolves with social events. It is commonly used to research social programs to make judgments about targeted social challenges. It is also commonly used for the development, execution, effect, and efficiency of interventions that address social issues^{5,6,7}. Fetterman⁶ presents empowerment evaluation in terms of building communities of practice (COP), cultural learning experience, and organizational evaluation for the improvement of individuals and self-determination. All stakeholders in any given program carry on their own assessments: an external evaluator often serves as a mentor or facilitator depending on available resources, referred to as “internal program capabilities”⁶. A theoretical model for the empowerment evaluation was greatly described by Fetterman and Wandersman⁸ to represent the different principles to this approach as: Improvement, community ownership, inclusion, democratic participation, social justice, community knowledge, evidence-based strategies, capacity building, organizational learning, and accountability^{9,12}. Michael Quinn Patton stresses that reviews around this approach often question the conceptual meaningfulness and practical applications of empowerment evaluation⁹. As nicely worded by Patton⁹: “Empowerment evaluation takes a lot of time, as does any highly process-oriented approach. Time for involvement, time for buy-in, time for feedback, time for back-and-forth, time to do it right. Empowerment evaluation is labor- and time-intensive” (p. 413).

Begin with the end in mind. It is very helpful to frame your work for reporting and product development purposes before executing the evaluation process¹⁰. In this article, the author describes the evaluation process in which one can use a logic model to guide in the process and planning as a part of participative and empowerment evaluation processes with community-based organizations. The strength of this method is that in practice facilitating participative evaluator at multiple levels are reduced resistance to evaluation and clear expectation among various stakeholders in the evaluation process. This contributes to the fuller participation and collaboration of stakeholders throughout the evaluation process¹⁰.

Since empowerment evaluation is a community based process model, its underlying assumptions are stakeholders’ active participation and support for the evaluation process. It defines its community’s ability to understand and control social forces for social improvement¹¹.

Empowerment theory is defined as the meaningful participation of the individuals that are being evaluated in the design, implementation, and administration of the evaluations. According to Scriven¹², meaningful participation is analogous to “good-faith negotiation in union bargaining: it is not precise, but we have a body of ‘case law’ on it that defines it well enough for most practical purposes”¹² (p. 166).

Lastly, empowerment theory impacts this evaluation approach due to its pragmatic style that places power in the hands of individuals and groups at the local community level to be change agents and to find quality and cost-effective solutions to their community’s challenges¹³.

Since empowerment evaluation has been used as a social program evaluation, it has been heavily used to collect and analyze information to measure information about a program’s performance and effectiveness by answering prescribed questions. A crucial phase in the design process of an empowerment evaluation plan is to define the questions that must attend to the evaluation⁵. There are times when this process is done quickly with little attention, however it is important to spend close attention and be detailed in constructing the questions. A carefully crafted set of evaluation questions makes the evaluation more meaningful and robust, leads to proper and a thoughtful program planning process, and serves as a foundation for essential conversations about the audience who is interested in the findings from our answers and how they will be applied to research and practice. Indeed, assembling such questions and planning how to answer them is the chief approach in which an evaluation is designed to the unique conditions related to each program investigated.

In the BMCA feedback is provided verbally during the weekly lab meeting. During these meetings, both mentors and mentees participate in discussions about their research progress and upcoming deadlines and milestones. These informal meetings serve as means for checking in terms of the progress of the program and the implementation evaluation process. Meeting minutes are recorded by the education coordinator and posted onto Moodle (online database) within two business days of the meeting. By posting the meeting notes online, the meeting content is shared with present participants and also serves as an archive document for future evaluation analysis.

5. Program Outcomes and Assessment

The previous section covered how to monitor the BMCA program’s process and performance through empowerment evaluation approach. Ultimately, the goal of the BMCA program is to make social change (i.e. changing WTCC students’ understanding of engineering opportunities) and to be beneficial to all stakeholders participating in the BMCA program. As Rossi⁵ stated:

The changed conditions are the intended outcomes or products of the programs. Assessing the degree to which a program produces these outcomes is a core function of evaluators. A program’s intended outcomes are ordinarily identified in the program’s

impact theory. Sensitive and valid measurement of those outcomes is technically challenging but essential to assessing a program's success. In addition, ongoing monitoring of outcomes can be critical to effective program management. Interpreting the results of outcome measurement and monitoring, however, presents a challenge to stakeholders because a given set of outcomes can be produced by factors other than program processes. Assessing a program's effect on the clients it serves and the social conditions it aims to improve is the most critical evaluation task because it deals with the 'bottom line' issue for social programs. No matter how well a program addresses target needs, embodies a good plan of attack, reaches its target population and delivers apparently appropriate services, it cannot be judged successful unless it actually brings about some measure of beneficial change in its given social arena. Measuring that beneficial change, therefore, is not only a core evaluation function, but also a high-stakes activity for the program. For these reasons, it is a function that evaluators must accomplish with great care to ensure that the findings are valid and properly interpreted. For these same reasons, it is one of the most difficult and, often, politically charged tasks the evaluator undertakes. (p. 204).

The program outcomes and assessment section considers how to best identify the changes in the BMCA program and the expected outcome based on these changes, how to devise measures of these changes, and how to interpret such measures. Consideration of the BMCA program effects starts with the concept of outcomes. In agreement with Fetterman⁷, empowerment theory is an all-inclusive approach that includes:

...systematic and continual critical reflection and feedback. Advocacy and potential controversial feature of the approach is warranted only if the data merit it. Empowerment evaluation is fundamentally a democratic process. The entire group – not a single individual, not the external evaluator or an internal manager – is responsible for conducting the evaluation. The group thus can serve as a check on its own members. The evaluator is a co-equal in this endeavor, not a superior and not a servant; as a critical friend, the evaluator can question shred biases or 'group think'. As in the case in traditional evaluation, everyone is accountable in one fashion or another and thus has an interest or agenda to protect (p. 30).

The following empowerment evaluation is used as a summative evaluation and as a post survey to be administered within one year of the student participants' completion of the mentoring BMCA program experience at NCSU.

Survey: North Carolina State University BioMed Connect Alliance (BMCA) Program
Purpose: To receive follow-up reactions of participants to BMCA
Administered To: students who participated and completed this summer program
Topics Covered: Program Evaluation (satisfaction, effectiveness, practical value, expectations, and engagement)
 Long term Impact (career development, career choice, and current academic major or lab experience)

BioMed Connect Alliance (BMCA) Program

Student Name: _____ Session: _____
 Current School & Grade Level: _____ Date of Birth: _____

- Are there favorite activities or things about this program that you liked? Please tell us about them.

- Are there things about this program that you think should be changed or improved? Please tell us.

Please rate the following activities. If you did not participate in an activity, then leave it blank.

Cell Culture Lab Training and Experiments

- How useful was this activity? Did you learn something interesting?
 Not at all useful Somewhat useful Undecided Useful Very useful
- How enjoyable was this activity? Was it an appropriate level of difficulty (not too hard or too easy)?
 Not at all enjoyable Somewhat enjoyable Undecided Enjoyable Very enjoyable

Comments: _____

Data Analysis of experiments

- How useful was this activity? Did you learn something interesting?
 Not at all useful Somewhat useful Undecided Useful Very useful
- How enjoyable was this activity? Was it an appropriate level of difficulty (not too hard or too easy)?
 Not at all enjoyable Somewhat enjoyable Undecided Enjoyable Very enjoyable

Comments: _____

Weekly Lab Meetings

- How useful was this activity? Did you learn something interesting?
 Not at all useful Somewhat useful Undecided Useful Very useful
- How enjoyable was this activity? Was it an appropriate level of difficulty (not too hard or too easy)?
 Not at all enjoyable Somewhat Enjoyable Undecided Enjoyable Very enjoyable

Comments: _____

Final Poster Presentation (if applicable)

9. How useful was this activity? Did you learn something interesting?

Not at all useful Somewhat useful Undecided Useful Very useful

10. How enjoyable was this activity? Was it an appropriate level of difficulty (not too hard or too easy)?

Not at all enjoyable Somewhat enjoyable Undecided Enjoyable Very enjoyable

Comments:

Concluding Thoughts

11. Is there anything that you did not get a chance to do that you would have liked to do?

12. Do you think you accomplished something? If so, please tell us what your biggest accomplishment was.

13. How likely are you to participate in future BMCA opportunities at NC State University?

Not likely Somewhat Likely Undecided Likely Very Likely

14. How did this project contribute to your academic scholarship?

15. How did this program impact your career development?

16. How did this program impact your academic and/or career choice?

17. Describe your current academic major and/or lab experience?

6. Stakeholders and Dissemination of Results

The stakeholders for this evaluation design include the NCSU research and education coordinators, NCSU COE faculty and WTCC Partners, and the funding agency. The research and laboratory coordinator for the BMCA program is Dr. Rex Jeffries, who is a current post-doctoral associate at the department of biomedical engineering (BME). The education coordinator is also the internal evaluator and creator of this evaluation design plan, Olgha Davis, a doctoral student at the LPAHE at NCSU. In addition to the coordinators, NCSU faculty members include Professors Christine Grant and Michael Gamcsik from the COE, and Professor Tuere Bowles from the LPAHE. WTCC is also a stakeholder in this project, more specifically the 3MP Pathways Male Mentoring coordinator, William Kincy, and also WTCC students who

participated in the mentoring incubators, Kenny White, and future WTCC students. Lastly, NCSU Extension and Engagement office is the funding agency for this work and serves a primary stakeholder in this evaluation design.

The evaluation results will be disseminated in terms of a final report given to the funding agency (NCSU Extension and Engagement Office) by fall 2013. The report will include our findings and observations from the development of the BMCA program infrastructure, the mentoring of the students, and the research outcomes to a broader audience on the local and national level through our department and university website.

7. Conclusion

In conclusion, this research paper presented the program and evaluation design for an existing mentoring research program for underrepresented students at North Carolina State University. The (BMCA) initiative targets African-American students at various academic levels to further enhance their understanding of the translational aspects of research and educational activities to express informed career choices to maximize their experiences in Biomedical Engineering.

8. References

- [1] The Schott 50 State Report on Public Education and Black Male, 2012.
<http://blackboysreport.org/urgency-of-now/index.html>
- [2] Grant, C. (2006). Mentoring. In Pritchard, P., A. (Ed.), *Success strategies for women in science: A portable mentor* (pp. 85-106). Burlington, MA: Elsevier Press.
- [3] The National Science Foundation, <http://www.nsf.gov/statistics/wmpd/minwomen.cfm>
- [4] Coffman, J. (1999). *Learning from Logic Models*, Cambridge, MA: Harvard Family Research Project.
- [5] Rossi, P. H., Lipsey, M. W., & Freeman, H. E. (2003). *Evaluation: A systematic approach* (seventh edition). Thousand Oaks, CA: Sage Publications.
- [6] Fetterman, D. M. (2002). Empowerment evaluation: Building communities of practice and a culture of learning. *American Journal of Community Psychology*, 30(1), 89-102.
- [7] Stufflebeam, D. L. (1994). Empowerment evaluation, objectivist evaluation, and evaluation standards: Where the future of evaluation should not go and where it needs to go. *American Journal of Evaluation*, 15(1), 321-338.
- [8] Fetterman, D. M., & Wandersman, A. (2007). Empowerment evaluation: Yesterday, today, and tomorrow. *American Journal of Community Psychology*, 28(1), 179-198.

- [9] Patton, M. Q. (2005). Toward distinguishing empowerment evaluation and placing it in a larger context: Take two. *American Journal of Evaluation*, 26(3), 408-414.
- [10] Andrews, A. B. (2004). Start at the end: Empowerment evaluation product planning. *Evaluation and Program Planning*. 27(1), 275–285.
- [11] Chrisma, N. J., Senturia, K., Tang, G., & Gheisar, B. (2002). Qualitative process evaluation of urban community work: A preliminary view. *Health Education & Behavior*. 29(1), 232-248.
- [12] Scriven, M. (1997). Empowerment evaluation examined. *American Journal of Evaluation*, 18(1), 165-175.
- [13] Fetterman, D. M. (1994). Empowerment evaluation. *American Journal of Evaluation*, 15(1), 1-15.
- [14] Smith, N. (2007). Empowerment evaluation as evaluation ideology. *American Journal of Evaluation*, 28(1), 169-178.
- [15] Torres, R. T., Preskill, H. S., & Piontek, M. E. (1996). *Evaluation strategies for communicating and reporting: Enhancing learning in organizations*. Thousand Oaks, CA: Sage Publications.