

In the Footsteps of Katharine Wright: Promoting STEM Women through LEADER

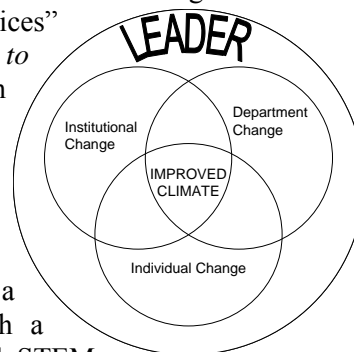
(Launching Equity in the Academy across the Dayton Entrepreneurial Region)

I. Introduction:

Since the time of the Wright Brothers' bicycle shop, the Dayton, Ohio region, now approaching one million residents, has established a heritage of scientific and technological innovation. This region is home to more than a dozen institutions of higher learning and also to the principal research and graduate education arms of the US Air Force at Wright-Patterson Air Force Base. Women have contributed prominently to this heritage from the start. Katharine Wright was the only member of the Wright Brothers' family to complete college; she contributed ideas, funding, and organization to the developing science and business of powered flight, and she is one of the few American women to be awarded the French Legion of Honor. Yet now, a century later, while Wilbur and Orville are household names, few know of Katharine's talents and contributions. This disparity is emblematic. Today, many of the issues recognized nationally as important to women in STEM disciplines—issues of recruitment, retention, and climate—also persist in Dayton's regional universities. In this proposal a consortium (LEADER) of four diverse institutions of higher education in the Dayton region proposes to apply models and methods from social science to improve the climate for STEM women at levels ranging from the individual to the unit and the institution. We envision that through LEADER, Dayton can acquire renown as a community of STEM practice that welcomes women scientists and provides an environment promoting satisfaction and success. Doing so will extend the trajectory established by Wilbur and Orville Wright—and by Katharine.

II. LEADER, a consortial approach to achieving ADVANCE Institutional Transformation* Goals:

The underrepresentation of women in STEM academic positions is a nationwide concern [National Academy of Sciences (NAS), 2007]. This reflects gender disparities both in the pipeline leading to careers in academia and in the inner workings of the academy. Underlying the persistence of these problems are features of institutional climate that are rooted in the often nonconscious attitudes and behaviors of individuals. The implicit biases we all hold disadvantage women. These disadvantages are cumulative over time. Transformation of climate is thus fundamental to achieving ADVANCE objectives. With three rounds of ADVANCE sites now funded, "best practices" are becoming available to the STEM community; however *a commitment to take corrective action often is lacking*. In this proposal, our research model is grounded in social psychology and targeted to alter attitudes and behaviors of individuals, departments and institutions by using a combination of gender schema education, persuasion theory, and social contracts. Institutions transform behavior through cultivation of a normative environment that legitimates and motivates compliance. As recently recommended (NAS, 2007), this proposal conjoins the efforts of a diverse group of institutions (public, private, majority, minority) with a history of STEM collaboration and a shared goal of advancing regional STEM women. The proposed inter-institutional collaboration (LEADER) with associated accountability will transform the diverse partner institutions to collectively achieve greater gains in the success of STEM women than could be achieved individually. Reciprocal resource commitments and interdependence as well as cultural diversity will help ensure consortium success largely through social contracts that help increase peer pressure (Provan, 1984; Daas & Teng, 1998). We anticipate changes in climate indicators (e.g., more favorable attitudes, intentions, behaviors) of approximately 10% per year, which will provide



* LEADER's primary objective is transformation of the individual partner institutions, and, as such, is submitted as an IT proposal "from a group of institutions" rather than as PAID (NSF 07-582).

an environment conducive to consortium-level activities. Over 5 years the goal is to increase by 10% both the total representation of STEM tenure-track women as well as the percentage of those women holding the rank of full professor. If successful, the consortial approach would be exportable to other clusters of universities in metropolitan regions with a strong STEM emphasis.

Launching Equity in the Academy across the Dayton Entrepreneurial Region institutions:

LEADER institutions are located in close proximity to each other and collectively constitute an academic STEM community comparable in size to a large state institution (30,000 students and 450 STEM faculty).

- Wright State University (WSU, public doctoral, 13,500 undergraduate/3,500 graduate students)
- University of Dayton (UD, private Catholic, 7,000 undergraduate/2,500 graduate students)
- Central State University (CSU, public, minority serving, 2,000 undergraduate students)
- Air Force Institute of Technology (AFIT, federal, 800 graduate students)

LEADER specific aims are:

- a) To conduct a comparative analysis of climate for STEM women across the institutions and thereby identify best practices related to recruitment, retention, and advancement,
- b) To initiate gender schema education and a campaign based on persuasion theory that will promote new norms of expectation and thereby facilitate implementation of those best practices, and
- c) To implement social contracts across the consortium that promote transparency and accountability for the transformation of the climate leading to recruitment, promotion and success of STEM women regionally.

The LEADER consortium will determine whether a collective of diverse higher education institutions in a metropolitan region can effect institutional transformation that proactively creates a sustainable women-friendly STEM culture.

III. Lessons learned from prior ADVANCE projects:

This application grew out of a prior proposal submitted by WSU that received excellent reviews but was not funded. WSU will serve as the host institution for LEADER, and so we note some of the ADVANCE-related activities at WSU that resulted from that previous effort. Galvanizing 40 STEM faculty to work on the 2005 proposal clearly paid dividends. In the short time since those discussions, Wright State has hired 9 women STEM faculty, promoted 3 to full professor, tenured and promoted 4, and recognized 2 with the Presidential Award for Early Career Achievement. One senior woman was recently appointed as the founding director of the Nanoscience Center. In the 5 years before our ADVANCE planning only 15% of WSU internal research grants went to women, in the two years since, that proportion has risen to greater than 50%. In addition, a Women in Science philanthropic giving circle, believed to be the first of its kind nationwide, has been launched to provide development funds, such as seed funding for research, to support STEM women.

To further kindle and educate the WSU STEM community on issues of STEM women, a workshop on “Widening the STEM Pipeline: Work/Life balance” was held in April, 2007. Two members of the University of Michigan STRIDE (Science, Technology, Recruiting to Increase Diversity and Excellence) committee (Drs. Wayne Jones and John Vandermeer) spoke about the impact of gender schemas on recruitment and evaluation of underrepresented faculty. Materials developed by the STRIDE committee now are available to our search and evaluation committees. In addition to the University of Michigan (UM), our ADVANCE planning team members have made personal contacts (extensive telephone conversations or in-person visits) with ADVANCE project personnel at Georgia Tech, Colorado State, Utah State, and University of California (UC)–Irvine. These discussions have provided our team with insight into existing resources for enhancing recruitment, evaluation, mentoring, and coaching of women STEM faculty and for assessing departmental climate.

IV. The Dayton STEM landscape: past, present, and future:

Dayton has been a center of technology and innovation for more than a century. In recent years, Dayton has fostered a transition from its historical reliance on manufacturing jobs with ties to the faltering domestic automobile industry to a more modern, high-tech research base in emerging technologies. Many of the industries now forecast for regional growth are in STEM fields, including sensors, alternative energy, advanced data management, health informatics, advanced materials and manufacturing (composites, nanomaterials), emergency medicine, and human factors and performance. A labor market analysis forecasts over 7000 vacancies in the STEM employment sector as a result of the Base Realignment and Closure Commission (BRAC) that will move aerospace medicine and sensors research from other bases to Wright-Patterson Air Force Base (2009–2011). This STEM expansion through BRAC presents an exceptional opportunity to recruit STEM women and their partners to the region (see <http://www.bizjournals.com/dayton/stories/2007/11/19/daily2.html>). It has been well recognized that achieving this economic transition will be facilitated by—indeed, likely demands—collaboration among regional STEM education and economic institutions. Examples of such collaborations already in place in Dayton are:

- *EDvention*: a P-16 educational initiative funded in part by WSU and UD to systemically, strategically and collaboratively strengthen STEM education in the Dayton region. Recently Dayton was selected as the Ohio location of the National Governor’s Association STEM Center to acknowledge the rich diversity of resources the area can offer STEM.
- *Dayton Area Graduate Studies Institute*: DAGSI (www.dagsi.org) was established in 1994 as a partnership of the graduate engineering schools from AFIT, UD, and WSU. The DAGSI infrastructure allows graduate engineering students to integrate coursework from the partner institutions, to collaborate on state-funded research projects, and to construct advisory committees that include consortium faculty.
- *Wright Centers of Innovation (WCI)*: Two of the WCIs funded from Ohio’s Third Frontier initiative are located in Dayton. The Institute for Development and Commercialization of Advanced Sensor Technology (IDCAST) involves research groups from both UD Research Institute and WSU. DaytaOhio, the Wright Center for Advanced Data Management and Analysis, is located at WSU.
- *Ohio Science and Engineering Alliance and other STEM pipeline initiatives*: Dayton institutions of higher education have effectively partnered on multiple STEM pipeline initiatives. All collaborate on a statewide LSAMP, the Ohio Science and Engineering Alliance, and subsets of the LEADER institutions have successfully collaborated on previously federally funded initiatives (e.g., WSU and UD have partnered with Central State on multiple NSF and NIH grants to increase minority participation in research). At the time of this writing, LEADER institutions, along with regional 2-year community colleges, have joined forces to take advantage of recently enacted statewide STEM initiatives in the form of joint proposals to develop consortial arrangements for increasing STEM undergraduate and graduate students, to prepare more STEM teachers, and to anchor a STEM school around Dayton’s legacy of powered flight.

In sum, the Dayton region is emerging as a model for STEM collaboration within the state and nationwide. The purpose of the LEADER consortium will be to build upon well-established relationships among the partners to benefit success of STEM women faculty in a region that is committed to growing STEM employment and economic development.

LEADER: learning from diversity. The cultural norms and institutional policies at the partner institutions are as diverse as their histories and demographics. Thus, we believe that a collaborative approach to understanding and enhancing the environment for STEM women in the academy will provide fruitful grounds both for evaluating best practices and for creating a sustainable, progressive regional environment.

Wright State University (WSU) is a young (40 years), comprehensive institution, Carnegie Category RU/H, with 17,000 students (77% undergraduate). WSU's mission is to be a catalyst for educational excellence in the Miami Valley with an emphasis on *access* to scholarship and learning (www.wright.edu). STEM units reside in the colleges of Science and Mathematics (CoSM), Engineering and Computer Science, and the Boonshoft School of Medicine. WSU faculty are represented by AAUP in a collective bargaining unit that is recognized nationally as a leader in the transparency of processes and procedures, many of which enhance the success of STEM women. The AAUP Committee "W" has been collecting and evaluating data on the status of the institution's women faculty and has proactively participated in the preparation of this proposal. WSU has a Women's Center that provides programming, and professional and personal development workshops for women as well as advocacy and referral services. The interdisciplinary Women's Studies program has both undergraduate and graduate offerings. WSU established the Miami Valley chapter of the Association for Women in Science (AWIS) and hosts a Society of Women Engineers (SWE) chapter. Women have progressed or been hired into administrative leadership positions in STEM units over the past 10 years, including the current Dean of CoSM and former Chair of Biology (PI Michele Wheatly); Chair of Pharmacology; Acting Chair of Mathematics and Statistics, and past Chairs of Anatomy and Chemistry. WSU also has a strong tradition of serving students and faculty with profound disabilities; the two women candidates with quadriplegia presently in STEM doctoral programs are evidence that WSU has the accessibility features and the disability acceptance to grow a pipeline for STEM women faculty with profound physical disabilities. A new doctoral concentration in Technology Based Learning with Disability, that has received IGERT funding, confirms WSU's reputation in the field of disability programming. WSU has a unique doctoral program combining Human Factors and Industrial Organizational Psychology and faculty who perform research on organizational change. Dr. Tamera Schneider, along with her students, will lead the social science research that frames this proposal.



University of Dayton (UD), a Carnegie RU/H institution, was founded in 1850 by the Marianists. It is the largest private university in Ohio and is a top ten Catholic institution. UD is committed to transformative education, preparing students for lives of personal and civic responsibility (www.udayton.edu). STEM units reside in the College of Arts and Sciences and the School of Engineering. A Women's Center offers programming, advocacy and support for campus women generally, and STEM-specific campus groups include Women in Engineering, Conversations Among Women in Mathematics, Women in Science and Math, and a campus chapter of SWE for faculty and students. A meta analysis of institutional reports on the status of women in higher education has recently been completed. UD has demonstrated regional leadership in recently completing a series of climate assessments under the leadership of the President's Advisory Council on Women's Issues. The university has been highly successful in hiring women Deans in the School of Law, in the School of Business, in University Libraries, and as Vice President for Student Development and Dean of Students. In 2003, a decade after the first assessment, the Advisory Council concluded that while there had been progress in the hiring of women in senior administrative positions, challenges remained. Hiring and advancing women faculty in some of the key sciences, and particularly in engineering, requires continued efforts. These studies provide a foundation for further action. Dr. Peggy DesAutels (Philosophy) studies gender schemas in STEM fields and will support the social science context that frames this proposal.



Central State University (CSU), which gained full independent status as a state university in 1965, is a public, Carnegie Bac/Diverse Historically Black College/University (HBCU) with approximately 2000 students. CSU is an open access institution with emphasis on programs of importance to African American students. Among these are "programs in scientific and technological fields where minorities have traditionally been underrepresented and in which there is excellent future growth



potential” (www.centralstate.edu). CSU has Colleges of Education, Arts and Sciences, and Business and Industry, the latter includes Departments of Manufacturing Engineering and Water Resources Management. Recently, the State committed to substantial expansion of CSU, with an objective of tripling the student body in 10 years as described in the university’s Speed to Scale Executive Summary (<http://www.centralstate.edu/academics/news/speed2scale/>). Thus, CSU presents notable opportunities for faculty recruitment and development.

The Air Force Institute of Technology (AFIT) traces its roots to the early days of powered flight, when the Air School of Application was established at McCook Field in Dayton in 1919. Today, AFIT is the Air Force's graduate school of engineering and management as well as its institution for technical professional continuing education (www.afit.edu). AFIT currently enrolls over 800 officers, enlisted, and civilian personnel from the U.S. Air Force, Army, Navy, and other defense-related agencies as well as selected international military officers and U.S. citizens. AFIT's first female commandant, Brig Gen Paula G. Thornhill, Ph.D., assumed command in 2006.



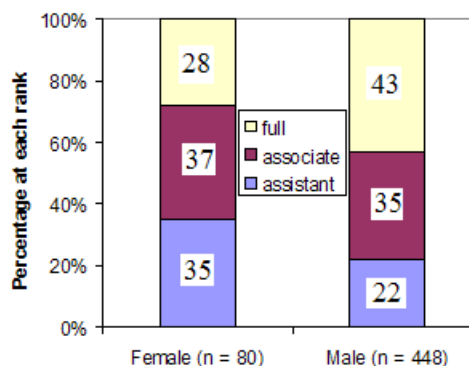
Present and projected scope of the LEADER consortium: Collectively this academic community constitutes about 450 tenured and tenure-track STEM faculty. Across the consortium, women are represented at levels consistent with national norms (18%; Curry, 2001), and the percentage representation across the broad STEM fields mirrors patterns published in the NSF SESTAT report (NSF 07-315) for 4-year institutions. The majority institutions (WSU and UD) both show higher percentages of women in the natural and mathematical sciences as opposed to physical and engineering fields. AFIT STEM units are skewed toward engineering subdisciplines and, as such, include few women. The minority institution has a high percentage of women in the sciences and, impressively, CSU’s STEM faculty includes around 80% from minority populations, strikingly different from the two majority institutions.

<i>STEM Field</i>	<i>WSU</i>	<i>UD</i>	<i>CSU</i>	<i>AFIT</i>	<i>NSF¹</i>
	♀/Σ (%)	♀/Σ (%)	♀/Σ (%)	♀/Σ (%)	(%)
Science					
Natural	23/76 (30)	8/30 (27)	3/7 (43)	0/1 (0)	(39)
Physical	7/39 (18)	1/25 (4)	1/4 (25)	1/14 (7)	(23)
Technology	0/0 (0)	3/15 (20)	0/7 (0)	0/0 (0)	
Eng/Comp Sci	7/63 (11)	5/51 (10)	0/7 (0)	1/34 (3)	(11)
Mathematics	8/30 (27)	6/17 (35)	1/7 (14)	1/7 (14)	(27)
Totals	45/208 (22)	23/138 (17)	5/32 (16)	3/56 (5)	

¹NSF, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT), 2007

When our collective STEM academic community is disaggregated by rank, the population of STEM females is heavily weighted to the lower academic ranks (Sonnert and Holten, 1995; Fox, 1996; Vetter, 1996) whereas males are more strongly represented at terminal rank.

Collectively, we have many opportunities to change the existing landscape. Along with our diversity, the Dayton Region’s ability to promote the interests of STEM women is further augmented by the presence of the Air Force Research Laboratories (AFRL) that are home to another 381 STEM Ph.D.s (both civilian and military), 43

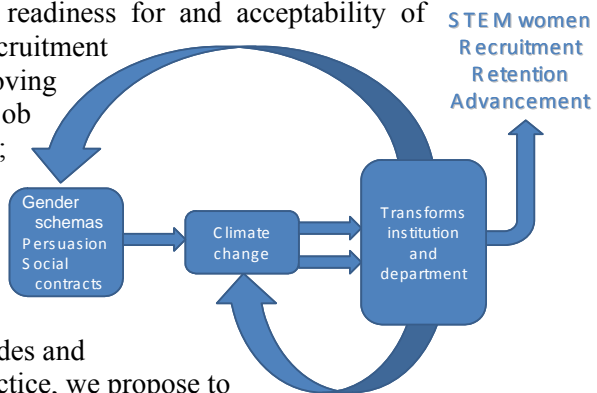


of whom are women, and University of Dayton Research Institute (linking education with Air Force Research) which houses 78 more STEM Ph.D.s on soft money, 7 of whom are women. Thus our regional Ph.D. level STEM community totals > 900, 130 of whom are women (14%). Moreover, in the next two to five years, BRAC will bring 300 additional Ph.D. level research positions to AFRL. Collectively, the proposed initiatives will thus have an impact on a community encompassing > 1200 Ph.D.-level researchers in STEM disciplines. The scope of this broader STEM community provides remarkable opportunities. Certainly it enhances employment opportunities for dual-career STEM couples, a problem that is more acute for STEM women than STEM men (Williams, 2001). Moreover, Wright-Patterson Air Force Base (Ohio's largest single employer with 24,000 employees and now under its first female commander) encompasses a diverse research portfolio totaling about \$1.6 billion. This STEM enterprise matches the research output of all Ohio Universities combined, and much of it is closely aligned with Dayton region universities and agencies.

In sum, Dayton, with its diverse institutions of higher education, alongside WPAFB and associated research units, has the potential to play a key role in development of STEM human capital.

V. Theoretical framework for LEADER research:

Organizations that effectively promote diversity in the workforce share a number of characteristics, including CEO involvement, changes to individual attitudes and behavior and institutional systemic practices, effective evaluation and assessment, and awareness among members that problems exist (Martins & Parsons, 2007). We seek to incorporate these characteristics into our initiatives within a framework drawn from the disciplines of social and organizational psychology. These models will be adapted to address issues of STEM women across levels from the individual to the institution. Our goal is to develop climates and cultures that enhance the readiness for and acceptability of specifically targeted initiatives known to enhance recruitment and success of STEM women. Further, by improving departmental climate, we hope to increase job satisfaction and retention of these women (Fox, 2001; Callister, 2006). The LEADER consortium proposes to explore three different domains in social science research. *First*, a comparative analysis of climate (surveys, focus groups, interviews) for STEM women across a diverse group of partner institutions will reveal existing attitudes and behaviors. *Second*, based on proven ADVANCE practice, we propose to initiate gender schema education on implicit gender bias for all faculty and administrators involved in hiring and evaluation. This will be followed by a campaign based on the biobehavioral model of persuasion that will promote new norms of expectation and thereby change explicit attitudes toward STEM women and facilitate implementation of those best practices. *Third*, we will implement social contracts both within an institution and across the consortium to promote transparency and collective accountability for the transformation of the unit/institutional climate leading to improved success of STEM women (Provan, 1984; Daas & Teng, 1998; Muthusamy, White & Carr, 2007). Ultimately these contracts target behavior change at the department head and upper administration levels.



Proposed social science research:

Gender schemas: Understanding the roots of the problem.

Schemas are nonconscious expectations we all hold about others based on their group membership. These expectations influence our judgment of others and also influence group members' expectations about how they will be judged. Schemas are applied more under circumstances of ambiguity, stress from

competing tasks, and lack of critical mass (Fiske, 2002). Gender schemas, nonconscious expectations for the behaviors and roles of males and females, play a significant role in gender inequities in STEM fields (NAS, 2007). Women from minority groups and those with disabilities are doubly disadvantaged by race and ability schemas.

Gender schemas disadvantage the recruitment of women into STEM fields and thereafter disadvantage their evaluation, advancement and compensation (Valian, 1998; NAS, 2007). Gender schemas influence review of CVs (Steinpreis, Anders & Ritzke, 1999) and applications for postdoctoral fellowships (Wenneras & Wold, 1997). When faced with equivalent credentials, whites, males and able-bodied individuals will get the “benefit of the doubt” (Dovidio & Gaertner, 2000). For example, letters of reference for professional women tend to be shorter and to contain twice as many doubt-raisers (e.g. “she has a somewhat challenging personality”), more grindstone adjectives (e.g. “hardworking”, or “conscientious”) and fewer standout adjectives (e.g., “brilliant”) compared with letters for men (Trix & Psenka, 2003; Valian, 2005). Gender biased evaluation over time can lead to cumulative disadvantage and lowered success rates through a self-reinforcing cycle (Cole & Singer, 1991). We believe that many STEM faculty and administrators at our respective institutions genuinely wish to recruit and advance STEM women, suggesting that gender schema training is especially relevant to our efforts (institutional letters of commitment attached). As Virginia Valian (2005) points out, “The moral of the data on gender schemas is that good intentions are not enough; they will not guarantee the impartial and fair evaluation that we all hold as an ideal.” A truism of clinical psychology is that awareness is the first step toward changing attitudes and behavior. One approach toward increasing awareness of gender schemas is to provide information on research in the field of evaluation bias to those who conduct evaluations including search and P and T committee members, department chairs, deans and provosts (NAS, 2007). Dr. P. DesAutels (Sr. Personnel) currently conducts such workshops at the University of Dayton and will implement a program of gender schema training (in the form of book groups and two-hour workshops) for the consortium. We hypothesize that the initiative to enhance awareness of gender schemas will improve implicitly and explicitly held attitudes about STEM women.

Assessment. To test this hypothesis the LEADER researchers will assess gender schemas implicitly and explicitly. *First*, Implicit attitudes will be assessed using the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998; Kiefer & Sekaquaptewa, 2007), administered at the beginning and end of each workshop, prior to the explicit attitude assessment. The IAT is designed to measure the strength of mental association between each of a pair of categories (e.g., women scientists vs. men scientists) and attributes (e.g., good vs. bad). Respondents categorize items as quickly as possible, which diminishes deliberation during the linking of category with attribute, in two conditions. In one condition, items representing woman scientist and good are linked with the same response (pressing a certain key on a computer), and items representing male scientist and bad are categorized with an alternate response (another key). In the second condition, items representing woman scientist and bad are linked with one keystroke and items representing male scientist and good are categorized with the alternate keystroke. The time difference in responding to items between the two conditions indexes the strength of association between the categories and attributes, or nonconscious attitudinal evaluations. That is, respondents who categorize items more quickly when woman scientist is paired with good (and man scientist with bad) are said to have an implicit preference for women scientists compared to men scientists (see <https://implicit.harvard.edu/>). *Second*, explicit attitudes will be assessed with 5 questions answered on a 5-point Likert-type scale [e.g., Women make good scientists—rated from strongly disagree (1) to strongly agree (5)] (Schneider, Rivers, & Lyons, 2007). Pre- and post-explicit attitude questions will vary to avoid carryover effects). We expect explicit and implicit attitudes to be only moderately related (Nosek, 2007), and are most interested in changes in each from pre- to post-assessment. Attitudes will be assessed indirectly by analyzing evaluation letters for STEM women and men for length, doubt-raisers, and adjectives (Trix & Psenka, 2003; Valian, 2005).

Biobehavioral model of persuasion: Toward a new norm of behavior and expectations.

The biobehavioral model of persuasion (BMP) will be employed as an approach to improve the general climate of our respective institutions and departments. BMP was originally developed to understand best practices for messages to promote healthy attitudes and behaviors with respect to personal health. However, this model focuses on fundamental psychological processes—attitude and behavior change—and so applies equally to promoting change in attitudes and behaviors in other domains like fostering equity in the academy.

The power of persuasive messages, and their increased effectiveness compared with information presented without concomitant motivational factors, can be illustrated by a program of educational interventions to promote healthy behaviors among low-income and minority women. In that program, initial focus groups elucidated initial knowledge levels, language use, and key health and personal concerns among the target audience (as will be conducted for the proposed research). From these focus groups, videos were created to present factually equivalent information that differed only in how the information was framed. The video focus was on either the benefits (i.e., gains) of getting a mammogram (e.g., “Getting a mammogram can save your life.”) or on the costs (i.e., losses) of not getting a mammogram (e.g., “Not getting a mammogram can cost your life.”). Our prediction, guided by prospect theory, was supported: more women exposed to the loss-framed videos (50%, vs. 36% for gain-framed videos) obtained mammograms six months after the intervention (Schneider et al., 2001). Similar results derived from a campaign to promote Pap testing (Rivers, Salovey, Pizarro, Pizarro, & Schneider, 2005). In both cases, the effect of the intervention was diminished at 12 months, indicating the need for periodic booster messages. We will incorporate this finding into our LEADER research program.

The BMP, informed by studies like those described above, predicts that how a message is presented will determine how the issue is evaluated. Specifically, challenging messages, those that promote a moderate level of personal concern (or personal relevance) and high levels of efficacy (i.e., the belief in one’s ability to engage in a recommended behavior), will be maximally persuasive. The BMP posits that compared to messages that are threatening and lead to avoidance, challenging messages evoke psychological and physiological sequelae that foster adoption of recommended behaviors. Psychological factors evoked by challenging compared to threatening appeals should include more positive and less negative emotion, more favorable attitudes, deeper message processing, greater message acceptance, stronger intentions to engage in recommended health behaviors, and actual behavioral engagement. Both laboratory and field experiments support these predictions (Feufel & Schneider, 2006; Schneider et al., 2007). From this foundation, our objective is to formulate persuasive messages that motivate attitude and behavior change concerning STEM women issues, and thereby promote our objective of improving the climate for STEM women in Dayton. Further, an improved climate will foster engagement with broader LEADER consortium initiatives.

Recent initiatives, using BMP-derived messages in a regional community outreach campaign to promote colorectal cancer screening (Feufel & Schneider, 2006), demonstrate the feasibility of scaling these methods to populations in excess of 10,000 people. In our ADVANCE initiative, we will implement an outreach campaign based on BMP to inform the STEM community about issues related to STEM women and to suggest courses of action available to members of that community. In so doing, we will improve institutional climate and thereby facilitate the implementation of initiatives targeted at promoting women in STEM. We hypothesize more favorable attitudes, intentions, and behaviors will result and will be reflected in improved scorecard outcomes.

We do recognize that factors other than message content, such as message source, recipient, or context, can influence attitudes (Petty & Wegener, 1998). The source of the message can enhance persuasion; for example, effectiveness is enhanced when a message is delivered by an expert like the National Academy

of Sciences, one's Department Chair, or one who will not gain personally from attitude change (e.g., a white male scientist). Individual differences can also influence persuasion such that, for example, people who prefer contemplating information will process messages more deeply than those who do not like to process information. The context can influence processing such that a message identified as a LEADER message may not be processed by those who are hostile to STEM women issues. Processes that influence these persuasion variables include emotion, cognition, and behavior (Petty & Wegener, 1998). The present research examines these mediational variables at each assessment, and will use past research findings about message source, recipient, and context to complement our message efforts.

Assessment. The development of persuasive messages will be guided by a snapshot of the baseline climate of STEM Departments across LEADER institutions. To this end, we will continue ongoing efforts and systematize across institutions our method for conducting focus groups, interviews, and climate surveys. All STEM men and women will be recruited. Because similar efforts in other ADVANCE initiatives have elicited relatively modest response rates [e.g., University of Michigan, <http://www.umich.edu/~advproj>, 09/2002], we will utilize telephone interviews (brief versions of focus groups) to supplement focus group and climate survey responses. The objective of the focus groups and interviews will be to uncover issues pertinent to recruitment, retention, and advancement of STEM women. Climate surveys will be paper-and-pencil self-report surveys that query respondents about research, teaching, service, space, and perceptions of climate. They will be administered to all STEM faculty at each institution. Examples questions are, "My colleagues expect me to represent the point of view from my gender" (UM Survey of Academic Climate and Activities, <http://www.umich.edu/~advproj>, 09/2002) and, "The administration at the top levels of the department/college are supportive of women" (Fassinger, Scantlebury, & Richmond, 2004). Using survey items adapted from past ADVANCE projects will facilitate comparison of data across projects.

The responses to focus groups, phone interviews, and surveys will be disaggregated by gender, ethnic status, broad STEM field, and institution (Jones & James, 1979; see Callister, 2006 for additional survey instruments). Data will be collapsed across institutions, especially where departments have few women (e.g., some engineering disciplines).

We anticipate that formative evaluation of our baseline snapshot across LEADER institutions will reveal both best practices, which will be shared across institutions, and department-specific issues for STEM women, which will direct the construction of persuasive messages targeting particular attitudes, intentions, and behaviors. Numerous such messages will be pilot tested at each institution, and within pertinent Departments, a similar approach is used for health campaign research materials. Message effectiveness will be determined by examining pre- to post-message exposure change in attitudes, intentions, and self-reported behaviors. Attitudes will be assessed with multiple items that query preferences for women or men in STEM disciplines. Intentions will be assessed on a 5-point scale on items that query recent or intended activities, such as "...working with female colleagues on collaborative research projects in the past 3 months" (see Schneider et al., 2007).

The most effective messages will be administered intermittently in Departments, and across institutions throughout the duration of the ADVANCE project, and messages will be changed periodically. Persuasive messages will be brief. They will contain an initial statement that focuses on a personal concern, followed by a statement of action that addresses the concern. In some cases, messages will focus on facts that do not have a specific action, yet evoke personal involvement (e.g., asking a relevant question, using "You," see Rothman, Salovey, Turvey & Fishkin, 1993). Messages will be presented (or delivered in the case of email or hard copy mail) intermittently, and presented in different formats (e.g., different size and color of posters) so that message processing is enhanced due to their presence being unexpected. Messages will be presented in poster format, as emails from department chairs (to enhance message source), signs posted outdoors (e.g., billboards), pamphlets in STEM-department student and

faculty mailboxes, and other formats. They will not be conspicuously associated with the LEADER team so that message processing is more likely, especially for those less favorable toward issues of women in STEM. An example of a persuasive message is *"Is America still a global leader in STEM? Ensure continued prominence by discussing research with your female colleagues today (National Academy of Sciences, 2007)."* An example of a factual message is *"Did you know that 43% of STEM Ph.D.s are earned by women, yet only 20% work in science and technology."*

When examining outcomes for LEADER institutions we will again query attitudes, intentions, and self-reported behaviors. We will also be able to discern actual behavior change by investigating adherence to social contracts and changes in scorecard outcomes. Abbreviated follow-up focus groups, interviews, and climate surveys will be conducted annually to inform the updating of our persuasive messages as climates improve, as well as the refinement of scorecards.

Social contracts: Promoting institutional investment in change.

Whereas the focus on gender schemas addresses individual implicit (nonconscious) attitudes, and the BMP addresses explicit (conscious) attitudes, we recognize that environmental factors exert a large influence on individual behavior. Combining change efforts at individual *and* organizational levels is more effective than reliance on either alone (Noblet & LaMontagne, 2006). Our third approach addresses the institutional environment (NAS, 2007) by implementing contingency contracts, a form of social contract. Contingency contracts formalize the goals and responsibilities of parties involved in an exchange relationship, and they may (as in our case) define a reward structure for meeting those goals.

Such social contracts are most often employed to change individual behavior (Otto, Reilly-Harrington, Kogan, & Winett, 2003), but they are also effective tools for enhancing functioning and accountability of institutions (Heide, Wathne, & Rokkan, 2007). As the recent NAS (2007, p.240) report on STEM women noted with respect to civil rights enforcement, "institutions change behavior not because of the threat of sanctions, but rather because the law cultivates a normative environment that legitimates and motivates compliance." Social contracts are most effective when they are enacted at initial stages of behavior change and when provisions are negotiated and agreed upon by all partners. The use of contingency contracts has several functions for promoting LEADER initiatives at the institutional level. *First*, their co-authored development by LEADER advocates, department heads, and administration (guided by the initial formative evaluation of institutional needs for STEM women) will promote buy-in from all parties (Heide et al., 2007). *Second*, the contracts will define measurable and attainable goals, such as having department heads and all search committee members attend gender schema workshops. *Third*, progress toward goal attainment will be shared across institutions annually fostering accountability for reaching goals within units and institutions. Public sharing will facilitate discussions of best practices and of aids or barriers to achieving goals while at the same time enhancing pride for addressing nationally identified STEM goals. Contracts provide a way to both monitor and reward institutions for LEADER-friendly strategies. Further, these contracts are non-binding which provides an optimal basis for building trust across the consortium (Malhotra & Murnighan, 2002).

The ultimate goal for any behavior change is sustainable self-regulation, but before reaching this goal, people and institutions often need help from others – the multiple benefits that come from contingency contracts will create good habits which help to sustain behavior change. We hypothesize that contingency contract adherence will be related to improved scorecard outcomes.

Assessment. In general, contracts will focus on circumstances (e.g., economics, social support, cultural norms) that may facilitate or pose barriers to engaging in recommended ADVANCE-related behaviors. The joint goals delineated in contingency contracts can be larger goals such as increasing the number of women in an engineering department, or they can be smaller, supportive goals such as having search committee members, deans, P&T chairs, and department chairs attend gender schema workshops. The

extent to which departments and individuals participate in initiatives (e.g., attendance in gender schema workshops) will benefit institutional records and count toward adherence. Collaboration of the LEADER Director with LEADER Equity Advisors and the annual sharing of progress reports will promote good record-keeping. Attainment of, or progress toward, goals and initiatives will contribute to decisions about distributing LEADER program funds to participating units. Units will be asked to include statements as to how their proposed activities contribute to the goals of the LEADER initiatives. These statements reflect the contingency aspect of such contracts.

VI. Initiatives promoted by LEADER social contracts: Implementation within and across institutions:

Concurrent with and as a vehicle to implement the LEADER research agenda, the LEADER consortium will develop an administrative architecture both within and across institutions that will facilitate transformation of the climate and institutions for STEM women. Our expectation is that changes in climate induced by the LEADER research agenda will improve receptivity and implementation of LEADER initiatives. The purpose of the consortium will be to enable social contracting both within and across institutions, facilitating assessment via the LEADER scorecard (see below). In addition to data gathering and analysis, the consortium will be the clearinghouse for the gender schema training, the climate research and all of the research instrument analysis. But above the research agenda, the consortium will organize a number of centralized programming activities. Institutionally, consortium success starts with our department chairs and LEADER Equity Advisors.

Institutional administrative architecture and programs:

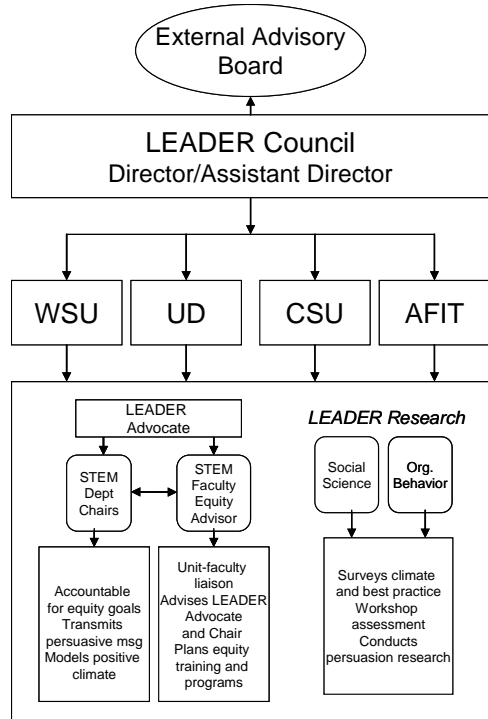
The central role for Department Chairs in implementing climate change: Faculty work life is centered in the department, and chairs establish modes of operation ranging from hiring practices to standards of promotion, assignment of space, inclusivity of departmental discussions, and more. Thus, we anticipate a primary role for chairs in all of the climate initiatives. Chairs will attend gender schema workshops; they will be involved in the transmittal of persuasive messages; and they will play central coordinating roles in annual assessment of departmental climate. Chairs will be encouraged to seek program funds to support activities that improve departmental climate or assist STEM women (see letters of support).

LEADER Equity Advisors: Modeled after the successful structure developed at UC Irvine, Equity Advisors (typically associate or full professors) will be appointed in proportion to the size and scope of the STEM constituency at an institution. These individuals, who will be selected based on track record of interest and support of underrepresented faculty, will be further trained in gender schemas. Operating at the unit or divisional level they will provide equity advice to the chair or dean as appropriate. They will report directly to the LEADER Advocate (see below, an upper administrator with responsibility for the diversity portfolio) and will coordinate data acquisition with the office of Affirmative Action. Their responsibilities will include: (1) facilitating bias free faculty searches through sharing best practice (UM STRIDE committee materials, strategies to enrich the pool, offering women candidates positive interview experiences); (2) reviewing annual score card data for their unit and alerting the chair/dean of inequities based on salary, space and professional development; and (3) implementing equity programming aligned with the unique diversity needs of their unit.

Professional support for STEM women: Research studies show that STEM women faculty carry the inordinate burden of family care responsibilities creating disruptions to research programs that compromise their advancement. Individual institutions will provide necessary program funds (institutional or philanthropic) to support special research requests from STEM women faculty.

LEADER consortium administrative architectures and programs:

LEADER council: A regional council will be established to promote equity in the academy among the partner institutions. With funding from this grant the initial purview will be women in the STEM academy. The intention is that in due course equity will be addressed for other underrepresented constituencies and that the administrative architecture will transition to a sustainable model by the end of the grant (see below). Each participating institution will have representation on the LEADER Council through a senior level administrator (LEADER Advocate, ideally a full professor at the level of Associate Provost) with institutional oversight for equity. Other governmental entities (AFRL) will have representation on the Council. Council will have oversight over all aspects of the project including setting benchmarks for success. Council will be charged with developing consortial level intentional structures (through their respective Provosts and Presidents) to facilitate partner placement, making Dayton a region of first choice for two-career STEM couples. Exploiting the experience of institutions such as URI, Utah State, and University of Montana PACE project, the consortium will capitalize on opportunities to work cooperatively to recruit STEM couples. Council will also facilitate sharing of best practices to advance STEM gender equity that will promote climate change, including: half-time tenure-track appointments; policies and procedures for tenure clock extensions; active service-modified duties; subsidized child care and parental leave policies; women friendly campus design (lactation stations, play equipment); offering family



friendly teaching and service assignments; and resource allocations (salary, lab space, technical support). An External Advisory Board will assess progress toward enhancing project goals.

LEADER administration will reside at the host institution (WSU) under a LEADER Director and administrative support (cost shared). Over the life of the grant, the cost of the Director position will transition to WSU support, ensuring sustainability (see WSU’s Provost’s letter). LEADER Administration will gather assessment data and administer consortial activities and programs including:

LEADER programming: The consortium will administer inter-institutional initiatives such as: equity training for administrators; workshops on bias-free hiring and evaluation; and programs (seminars, annual workshop) targeting STEM gender equity.

LEADER life support: A website will be maintained with regional job offerings for two career couples including academic and non-academic STEM openings as well as other professional placements. Managing work/life balance is a concern of any parent/elder care provider in the academy, but is a major concern for women, particularly those who are single parents or only children. The LEADER consortium will keep an up-to-date website of information on women’s health providers, child care and elder providers and other community support programs that are shared within the Dayton metropolitan region. Mechanisms to provide childcare to enable single women STEM faculty to travel to attend professional meetings will be explored including a child care cooperative.

LEADER mentoring program: Due to the small- to mid-size of some STEM departments at the partner institutions, women may be denied the benefit of having more senior women in the same

discipline to serve on promotion and tenure committees, pre- and post-tenure review teams, and mentorship teams. Our consortium provides a critical mass of prominent women across STEM disciplines, able to provide both mentoring and institutional service across institutions within the structures of our respective faculty evaluation and tenure processes. STEM men will also serve in mentoring roles. Grounded in our social-science based research, the LEADER mentoring program will adapt current best practices for establishing mentoring programs that work (Ragins and Kram 2007). Gender differences in the effectiveness of mentoring models will be considered in establishing mentoring programs (Ragins & Cotton, 1999).

LEADER coaching program: Coaching opportunities will be made available to all STEM women in the consortium, although more heavily advertised to those post-tenure. This will be provided through a combination of group activities (such as book groups and leadership workshops) as well as individual coaching for targeted women. Initially this will be provided by external consultants including Retired Admiral Deborah Loewer, Ph.D. (a WSU alumna, nationally known for executive training, who knows well the Dayton STEM community) and Carmen Bolanos, Ph.D., PCC, LPBC.

LEADER sabbatical brokerage: creating mechanisms for STEM-women professional development. Due to family care responsibilities and/or a non-movable partner, STEM women are often unable to take advantage of professional development leave opportunities. They often forego sabbaticals or take them “at home.” The LEADER consortium will promote and support placement opportunities between institutions, and with other regional organizations. For example AFRL can “borrow” academic faculty using the Intergovernmental Personnel Act (IPA) agreement. The assignee remains an employee of the host institution but is temporarily assigned to the Air Force Research Laboratories for a set of unclassified duties. AFIT has dedicated program funds to support STEM women from partner institutions to gain research experience (see AFIT budget justification). Alternatively, faculty could be on secondment between institutions with appropriate cross-institutional support. For example, STEM women faculty at CSU have a heavy teaching load and less opportunity for research. Through a sabbatical placement at either WSU or UD these women could build their research portfolio without having to leave the region.

LEADER annual score card: Capitalizing on the work of other ADVANCE projects such as the University of Michigan and UC–Irvine, the consortium will conduct an annual MIT-like analysis on the status of STEM women across all participating institutions using criteria established by NAS (2007). Indices will include: percentage of women in each STEM discipline; their rank, salary and research facilities; and hiring statistics for STEM faculty positions. Using climate measures aligned with our proposed biobehavioral model of persuasion, the consortium will examine the advancement of STEM women faculty across our institutions providing a comparative assessment with professional women engineers and scientists in the Dayton region; and will utilize a contingency contracting strategy to identify and remedy institutional barriers to progress.

VII. LEADER dissemination:

LEADER Council will promote the successes of regional STEM women (both academic and non-academic) through an annual report (along the lines of *Energeia* at Georgia Tech) that will be available in print and online. An annual regional daylong event focusing on “Women and Girls in STEM” will be offered through the Southern Ohio Council of Higher Education (which includes both 2- and 4-year regional institutions). Regional media (Dayton Daily News) will be targeted for coverage of issues pertaining to successes of STEM women as well as for regional recognition of successful STEM women (Dayton Top Ten Women; Ohio Women’s Hall of Fame). National dissemination will include sharing results with other ADVANCE projects through the annual PI meeting. Social science research findings will be shared through presentations at conferences such as the Society for Industrial/Organizational Psychology, the Society for Personality and Social Psychology, and the American Psychological

Association, and in publications in peer-reviewed journals, including *Journal of Applied Psychology*, *Journal of Personality and Social Psychology*, and *Gender and Education*.

Timeline for implementation of proposed research, LEADER initiatives, and assessment

RESEARCH ON CLIMATE	Year 1	Year 2	Year 3	Year 4	Year 5
Focus groups, interviews, climate surveys (snapshot)	█				
Formative evaluation: unveil best practices, STEM women issues	█				
Develop/pilot test STEM women persuasive messages	█	█	█	█	█
Departmental/Institutional display of messages	█	█	█	█	█
Snapshot of climate (assess message effectiveness)		█	█	█	█
Inform LEADER of best practices from formative evaluation	█	█	█	█	█
Conduct schema workshops, assess pre/post attitudes	█	█	█	█	█
UNIT LEVEL INITIATIVES					
Bias-free hiring (all search committee members)	█	█	█	█	█
Bias-free evaluation (assess annual evaluations)	█	█	█	█	█
Work with faculty equity advisor to promote use of mentoring, coaching, advancement and life support	█	█	█	█	█
LEADER CONSORTIUM LEVEL INITIATIVES					
Develop and revise scorecard	█	█	█	█	█
Assess/reward unit efforts at bias-free hiring (contract)	█	█	█	█	█
Assess/reward unit efforts at bias-free evaluation (contract)	█	█	█	█	█
Assess/reward unit for mentoring, coaching, life support use (contract)	█	█	█	█	█
Spousal placement	█	█	█	█	█
Sabbatical placement	█	█	█	█	█
Disseminate best practices and problems (scorecard)	█	█	█	█	█

VIII. Evaluation plan:

An External Advisory Committee will be appointed for objective oversight of LEADER. Membership will include women and men who have played a prominent role in other ADVANCE projects and who have some familiarity with the LEADER institutions and STEM environment. Individuals who have been approached are: Dean Sue Rosser, Georgia Tech; Wayne Jones, UM; Vice President Sue Bryant, UC–Irvine; Dolores Etter, alumna, National Science Board member. They will receive an annual written report from the LEADER consortium. The Advisory Committee meeting will take place annually at the ADVANCE PIs meeting with a third- and fifth-year site visits to the Dayton region. Formative and summative evaluation will inform LEADER research and consortial activities. Formative evaluation will be used in a Total Quality Management cycle to improve the consortium and all its activities. Qualitative indicators of success will be the improved climate for STEM women at the participating institutions, and the execution of inter-institutional activities for STEM women across the consortium. Summative evaluation will include the LEADER score card and numeric indices that denote gains in recruitment, and advancement of STEM women as well as numbers of search committee members and upper administrators trained in bias-free academic processes. As mandated, IT data will be entered into the ADVANCE portal and the project will be represented at yearly PI meetings.

LEADERShip Team

Michele Wheatly (WSU), (aka “Jeannette Oatson” in Rosser, 2004), Dean of Science and Mathematics, has performed NSF-funded research in comparative physiology for 24 yrs. As an administrator she has had significant experience directing large scale educational pipeline projects some of which are documented below. She will direct the LEADER consortium

David Goldstein (WSU) is Chair of Biological Sciences. His research has been funded by NSF, US-Israel BSF, and others. He has been involved in numerous initiatives to promote diversity in the life sciences, including being Co-PI on the NSF-funded UMEB grant (see below) and a long-term participant in NIH-funded programs to bring underrepresented undergraduate and high school students into research. In 5 years as Chair, he has hired 11 new faculty members—8 of them women. Dr. Goldstein will play a key role in implementing LEADER initiatives at WSU.

Kimberly Kendricks (CSU) is Assistant Professor of Mathematics. She is Assistant Director of a BISCA grant to diversify student learning through electronic classrooms, and is Co-PI of the NSF Banneker Scholars Program (pending) supporting minority STEM majors. A two-time winner of the NSF Southeastern Bridges to the Doctorate Program Competition, Mathematics Division, Dr. Kendricks' research applies mathematical theories in robotics. She will serve as CSU's lead on this project.

Joseph Saliba (UD) is Dean of the School of Engineering. His research has been funded by the Air Force Office of Scientific Research and the Air Force Material Laboratory. He has maintained an active consulting practice for over 20 years. Dean Saliba has been committed to diversity-related activities at UD, serving on the President's Task force on Diversity and the University Committee on Diversity in Community. He recently initiated a "grow-your-own" faculty program to support, develop, and advance women doctoral students for faculty appointments in engineering. He will lead UD's initiatives.

Tamera Schneider (WSU) is Associate Professor of Psychology and Human Factors Area Leader. She has received a decade of funding for research on attitudes, intentions, and behavior change in both field and laboratory settings. Many of her two dozen publications document the contribution of these studies to the biobehavioral model of persuasion. Dr. Schneider earned the President's Award for Early Career Achievement in 2004. She will conduct the social science research.

Other Senior Personnel:

Heidi Ries (AFIT) is Dean for Research and Associate Professor of Physics; she will coordinate LEADER implementation at AFIT. She previously served as PI for NSF's CREST project at Norfolk State University which led to the establishment of the institution's first STEM Ph.D. program.

Peggy DesAutels (UD) is Associate Professor of Philosophy. She holds graduate degrees in both Philosophy (Ph.D.) and Computer Science (M.S.). Dr. DesAutels has published books and articles on feminist ethics and moral psychology. She conducts gender schema workshops at UD, and will be in charge of that component of the LEADER program.

IX. Results from prior NSF support:

Wheatly and Goldstein: "UMEB: WSU partners with Wilberforce University to yield RESULTS" (Award # IBN 9975314), \$259,754, 1999-2005; To provide year-round research experience in environmental biology for 32 underrepresented students including 3 with physical disabilities.

Wheatly: "Creating Laboratory Access for Science Students (CLASS) with Disabilities" (Award # 0089396), \$509,140, May 2001- April 2005; To design introductory science lab and field experiences that are universally accessible.

Wheatly: "Research in Disabilities Education: Demonstration, Enrichment and Information", \$100,000, January 2005- December 2005; To ensure that approved K-12 STEM lessons available to educators on the Ohio Resource Center website are accessible to students with disabilities.

Wheatly: "Gateway into first year STEM curricula: a community college/university collaboration promoting retention and articulation" (DUE 0622466), \$1,997,620, 2006-2011. To create science and engineering introductory coursework for "not yet ready" entering STEM students.

Wheatly (CoPI): "IGERT: an interdisciplinary initiative on technology based learning with disability" (Award DGE 0504438), \$2,976,823, 2005-2010. To create a novel interdisciplinary Ph.D. concentration crossing 4 Ph.D. programs.