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Abstract

Purpose – The purpose of this convergent parallel mixed methods paper is to explore the mentoring experience within the context of a science, technology, engineering and math (STEM) specific mentoring program for urban, at risk, high school youth, using the Principles of Adult Mentoring Inventory (PAMI) as an instrument that modeled effective mentoring behavior. The study took place at a large, urban, Midwestern university in the USA.

Design/methodology/approach – A research design was developed and both quantitative and qualitative data were collected in parallel, analyzed separately and then merged to determine results. The PAMI instrument that measures six constructs of mentor effectiveness was administered to STEM mentors as a pre/post-test and enabled researchers to collect quantitative data. Researchers used focus groups to collect qualitative data in the form of transcribed interviews. This study sought to inform STEM mentoring program development by collecting both qualitative and quantitative data independently and simultaneously in order to confirm findings. Researchers used a convergent parallel mixed methods design to first, reinforce and corroborate the findings given the small sample size ($n = 8$); second, minimize alternative interpretations from data gathering and analysis, third, make clear various factors contributing to the effectiveness of STEM mentoring.

Findings – Throughout the mentoring experience, mentor perceptions of their mentoring abilities increased to be in the "more highly effective" range within PAMI. In five of the six constructs the results indicated mentors scored lower on the pre-test than they did on the post-test of the PAMI, meaning mentor perceptions of mentoring abilities improved overall during the course and the mentoring experience. Common themes from both quantitative and qualitative results were developed, are discussed using the PAMI constructs as organizers, and include communication, information, and gender differences.

Originality/value – This study added to the dearth of literature and investigations surrounding STEM mentoring. Many studies have concentrated primarily on mentoring but few have investigated the concept of STEM mentoring program best practices. The results of this study provided a multidimensional look at STEM mentoring programs that impact urban, at risk, high school youth.

Keywords Leadership, Mentoring, Coaching, Developmental coaching and mentoring, Prescriptive coaching and mentoring, Principles of Adult Mentoring Inventory (PAMI), Science, Technology, Engineering and Math (STEM), STEM coaching and mentoring

Paper type Research paper

Introduction

The development of a highly qualified, innovative workforce in Science, Technology, Engineering, and Math (STEM) is a global imperative if the grand challenges of this century are to be addressed. Nations on every continent report talent shortages and of the top ten most difficult jobs to fill, according to global employers, six are STEM related (ManpowerGroup, 2014). Research by Burke and Mattis (2007) finds that both Europe and the USA are concerned that immigrants from developing countries such as China, India, Russia, and Singapore, which previously made up a significant percentage of the STEM workforce, are choosing not to migrate as their home countries continue to

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develop a STEM based-economy and infrastructure and require their services. As a result, a recent report by the President's Council of Advisors on Science and Technology (PCAST) calls for the USA to produce approximately one million more STEM professionals during the next decade to meet demand (President's Council of Advisors on Science and Technology (PCAST), 2012). The report implores universities and community colleges to first, catalyze widespread adoption of empirically validated teaching practices; second, advocate and provide support for replacing standard laboratory courses with discovery-based research courses; third, launch a national experiment in post-secondary math education to address the math preparation gap; and fourth, encourage partnerships among stakeholders to diversify pathways to STEM Careers (PCAST, 2012).

Clearly STEM education is a global priority and in the USA it involves three objectives: first, to increase STEM literacy; second, to improve math and science teaching so students are no longer outperformed by those of other nations; and third, to expand career opportunities for underrepresented groups, including women and minorities (PCAST, 2012). The creation of high-quality STEM mentoring programs can assist in combating the issue of at-risk high school youth and underrepresented populations not choosing or often leaving STEM careers (Fifolt and Searby, 2010). Additionally, research has identified mentoring as an especially beneficial component for students as they transition from school to work (Fifolt and Abbott, 2008; Frehill *et al.*, 2004).

Mentoring definitions and best practice

The literature describes mentoring in a variety of ways. According to Cargill (1989) the interpersonal exchange between the mentor and the protégé may involve counseling, psychological support, protection, promotion, sponsorship, skill-development, and involvement in professional organizations. Inzer and Crawford (2005) believe that the definition of mentoring has been refined and embraces the fact that both mentor and protégé have something of value to contribute and gain from the mentoring experience. According to Ismail and Jui (2014) a review of current higher education student development programs finds that effective mentoring programs have two core elements; communication and support. Communication can take the form of delivering information about procedures, content, tasks or objectives of the mentoring program, conducting discussions about learning objectives, giving detailed explanations about the benefits of the mentoring program, and providing detailed performance feedback (Fox *et al.*, 2010; Stewart and Knowles, 2003). Support often takes the form of mentors providing emotional and instrumental assistance to mentees (Ismail and Jui, 2014).

In the STEM fields the findings of numerous researchers (DuBois, *et al.*, 2002; George and Mampilly, 2012; Peterson, *et al.*, 2012) suggest that when mentoring programs follow best practices developed from proven theoretical frameworks they are more likely to be effective. The Building Engineering and Science Talent (BEST) partnership has identified nine characteristics of effective STEM programs based on a comprehensive review of nationwide STEM efforts. Although the BEST partnership does not break these characteristics into groups, these characteristics seem to have two different concentrations: administration and implementation (Building Engineering and Science Talent (BEST), 2004).

Research suggests that programs that execute pairings through a structured, one-to-one model of matching, and that are based on the shared common interest of both mentor and mentee will result in better outcomes (George and Mampilly, 2012;

Tierney *et al.*, 1995). Scott (1992) found evidence that mentors and mentees who have input into the match will increase the probability of the match being successful. Other factors that result in positive mentoring outcomes include mentor screening, training, and recruitment (Garringer, 2007; Sipe, 2002).

Program supervision and support was found to be essential in establishing positive mentoring relationships by reducing mentor frustration (Sipe, 2002; Tierney *et al.*, 1995). Providing support, through mentor support groups, allows the opportunity for mentors to discuss challenges with other mentors who have faced similar challenges (Sipe, 2002). These types of interactions can help to increase mentor investment in the program, which was found to be another crucial element to achieving positive mentoring outcomes according to Garringer (2007) and Zachary (2000).

Research has shown that certain mentor characteristics can contribute to positive mentoring outcomes for youth. Rhodes and DuBois (2006) determined that characteristics of successful mentors include having prior experience helping others, being able to appreciate youth background and life situations, and prior youth mentoring. Additionally, Rhodes and DuBois (2006) revealed that mentors who exhibited a youth-centered approach had better mentoring relationships of a longer duration.

Studies have shown that several mentoring relationship characteristics contribute to positive outcomes. Research by Morrow and Styles (1995) indicated that mentoring could be divided into one of two approaches: developmental or prescriptive. Developmental mentoring provides support that centers on youth goals while prescriptive mentoring focusses on youth behaviors or goals the mentor decides upon. Research suggests that the quality of the mentoring relationship is closely linked to mentoring outcomes (Morrow and Styles, 1995).

There are few valid and reliable instruments that purport to measure the quality of mentoring, the experiences of mentees or the necessary constructs that good mentoring programs should embrace. The Principles of Adult Mentoring Inventory (PAMI) instrument was developed by Norman H. Cohen to provide professionals with a tool to help mentors become more effective (Cohen, 2003). The instrument measures six effective mentor behaviors (Table I) that constitute a complete mentor role.

The PAMI progressed through the preliminary development of scale, assessment by a variety of scholar and practitioner juries for construct and content validity, additional refinement for content validity, selection of a criterion group of reasonably experienced mentors, and statistical analysis and validation of scale utilizing ANOVA, MANOVA, one-way ANOVA, and cluster analysis (Cohen, 2008). The PAMI instrument can be

Emphasis	Focus on
Relationship	Sharing/reflecting on experiences. Empathetic listening. Understanding and acceptance
Information	Facts about career and educational goals
Facilitative	Exploration of interests/abilities/beliefs. Attainable objectives. Making own decisions about career and education
Confrontive	Respect about decisions. Insight into counter-productive behaviors. Evaluation capacity to change
Mentor model	Disclosing life experiences. Personalize relationship
Employee (student) vision	Critical thinking about career future. Personal/professional potential. Initiate change/negotiate transitions

Source: Cohen (2008)

Table I.
PAMI constructs

used to support and inform the training of mentors to work with adults or youth. According to Cohen (2008), the first five PAMI constructs can be used for any age level, however, when dealing with youth, the final construct can be changed from "employee vision" to "student vision."

STEM mentoring initiative

In January of 2010 a large, urban, workforce development agency in the Midwestern USA decided to build regional capacity to support careers in STEM by developing strategies that supported obtaining post-secondary education and training, leading to employment in a STEM field. In 2011, that workforce development agency entered into an agreement with a large, urban, university that created the STEM Mentoring Initiative that is the focus of this study.

This partnership was intended to focus on improving STEM education resources and pathways for two key audiences: disadvantaged youth and dislocated workers. The STEM Mentoring Initiative worked with at-risk high school youth to help them gain knowledge about STEM careers and to assist them with STEM training in order for them to gain the skills necessary to enter into high skill, high wage, STEM careers. Youth were classified as "at risk" by using data from the schools they attended. Any student who was identified by the federal government as eligible for free or reduced price lunch, free or reduced cost textbooks and/or who was identified as a special needs student with an Individual Education Plan was eligible for the program.

As part of the STEM Mentoring Initiative, the university created a STEM mentoring program. A STEM mentoring and leadership development course (see the Appendix) was offered to teach university students (mentors) how to mentor at-risk high school youth (scholars) who were interested in STEM fields. From the student body at a large, urban, research intensive, university, adult students who were interested in the credit-bearing STEM mentoring course had to meet criteria in order to be granted permission to enroll in the course. Some mentors agreed to be assigned to more than one scholar resulting in 13 scholars being matched with eight mentors. Throughout the fall semester of 2012 student mentors had contact with their scholars at least two hours per week. Course facilitators hosted one STEM event per month for the mentors and their scholars throughout the semester and provided ongoing support for mentors throughout the program. Monthly events included opportunities for group interactions to strengthen the mentoring relationship as well as STEM developmental opportunities.

The STEM Mentoring Initiative developed evaluation criterion that focussed on program design and implementation, at-risk youth population served, and mentor-scholar relationships. These three areas are defined by DuBois *et al.* (2002) as the benchmarks of successful mentoring programs. The STEM mentoring program aligned program goals with mentoring best practices by organizing mentoring themes around STEM subject matter, utilizing structured mentor-scholar matching strategies, and asking mentors to provide input into their mentoring match. Additionally, the program conducted training prior to mentors being matched with scholars and provided initial and ongoing support to meet the needs of mentors.

Based on research by Cohen (2003), Morrow and Styles (1995), and Rhodes (2005) the STEM Mentoring Initiative encouraged mentors to use a developmental approach to the mentoring relationship. Mentors focussed on building trust and included their scholars in decision making about mentoring activities whenever possible. Mentors would occasionally engage in activities that were not directly STEM-related activities such as eating a meal or going to a sporting event with scholars.

Methodology

The purpose of this study was to explore the mentoring experience within the context of a STEM-specific mentoring program for urban, at risk, youth, using the PAMI, as an instrument that modeled effective mentoring behavior. A convergent mixed methods design was developed based on research by Creswell (2009) and both quantitative and qualitative data were collected in parallel, analyzed separately and then merged to determine results. This study sought to inform STEM mentoring program development by collecting both qualitative and quantitative data independently and simultaneously in order to confirm findings. Researchers used a mixed methods design to first, reinforce and corroborate the findings given a small sample size ($n = 8$), second, minimize alternative interpretations from data gathering and analysis, third, make clear various factors contributing to the effectiveness of STEM mentoring.

In this study, the PAMI Inventory was given to STEM mentors before and after a mentoring experience and it was predicted that post-test scores on the PAMI would rise after completing the mentoring experience and taking a university-level mentoring course. Additionally, perceptions of the mentors regarding the mentoring experience using the six measures of the PAMI were discussed and recorded. Pre- and post-test scores of the behavioral dimensions of the PAMI, were compared with mentor perceptions, in an effort to better understand the challenges of STEM mentors dealing with urban, at risk youth and in order to inform best practices in STEM mentoring programs.

One research hypotheses (quantitative) and two research questions (one qualitative and one mixed method) guided this study:

RH1. After experiencing a mentoring course and a mentoring experience, STEM mentor participant scores will increase on the principles of adult mentoring inventory (PAMI) instrument. (Quantitative)

RQ1. How do STEM mentors describe the strengths, weaknesses, opportunities, threats, and challenges of a STEM mentoring experience with urban, at risk, youth? (Qualitative)

RQ2. In what ways can collecting quantitative data based on the PAMI instrument and merging that data with qualitative data from study participant focus groups contribute to a more comprehensive and nuanced understanding of the STEM mentoring experience? (Mixed method)

Procedure and timeline

This research combined qualitative and quantitative data collection methods resulting in four data points being collected (Table II) during the summer and fall of 2012. During a meeting in late August, the PAMI was distributed to the eight participating mentors and the results were reviewed after they had completed the instrument. The second data point consisted of conducting a researcher-facilitated focus group where mentor

Data point	Collection method
1	Principles of Adult Mentoring Inventory No. 1 – August 2012
2	Focus group 1 – October 2012
3	Principles of Adult Mentoring Inventory No. 2 – December 2012
4	Focus group 2 – December 2012

Table II. Data points, collection methods and timeline perceptions were ascertained. This happened in October of 2012 during the midway point of the mentoring course. Participants completed the PAMI a second time at the end of the mentoring course to produce data point three. Finally, after participants had taken the PAMI for the second time, a second focus group was conducted and that served as data point 4.

Participants

The STEM Mentoring and Leadership Development course was offered as both a graduate and undergraduate course in order to increase the overall pool of possible mentors. Brochures and electronic flyers were distributed to graduate and undergraduate students enrolled as STEM majors at the university and an online application was developed. Each potential candidate ($n = 18$) was prescreened by assessing the following key criteria: mentoring, professional, and social experiences; STEM major and minor areas of study; and availability to commit to the time demands of their assigned scholar(s). After the screening, eight mentors (six females and two males) were selected to participate in the course (see Table III). Upon meeting the selection criteria mentors were informed of the study and all mentors consented to participate. Researchers matched adult mentors with scholars on the basis of shared interest, geographic proximity, and gender (if requested by mentor or scholar).

The course syllabus and description (see the Appendix) outlined the expectations for the STEM Mentoring and Leadership Development class. During the first face-to-face class meeting, instructors distributed the informed consent for review, provided the syllabus for the course, and facilitated the mentor training PowerPoint. The PAMI (Cohen, 2008) was also administered at the first class meeting. Course facilitators explained the expectations of the course including participation in at least one STEM-related activity or excursion per month. STEM group activities were offered throughout the semester incorporating visits to industry, laboratories, local museums, and other STEM-related activities.

Focus groups

Utilizing the six constructs of mentoring effectiveness from the PAMI (Cohen, 2008) as a guide, facilitators conducted two, 2.5-hour focus group interview sessions with mentors in both October and December of 2012. These focus groups also allowed mentors to share their experiences and to gain perspectives from other mentors who participated in the course.

Mentor	Age	Race	Gender	Education[a]	Major	Career	STEM interest
1	51-55	White	F	Master	Technology	Higher education	Technology
2	26-30	White	F	Master	Technology	Higher education	Technology
3	< 21	Black	F	Bachelor	Computer info. tech.	Full-time student	Math
4	21-25	African	M	Master	Business admin.	Full-time student	Math
5	21-25	Black	F	Bachelor	Technology	Higher education	IT
6	< 21	African	M	Bachelor	Computer info. tech.	Information tech.	IT
7	51-55	White	F	Master[b]	Technology	Engineer	Engineering
8	26-30	Black	F	Master	Technology	Higher education	IT

Note: [a]Mentors were working toward the degrees indicated; [b]Working on second master's degree

Table III.
STEM mentoring course participants

Facilitators asked mentors to reflect on their individual thoughts and perceptions regarding strengths, weaknesses, opportunities, threats, barriers, challenges, successes, and mentoring processes within the constructs of the PAMI (Cohen, 2008). Facilitators looked for natural features of conversation as well as focussed discussion and encouraged open communication to assist in a relaxed environment.

Facilitators of the focus groups video-recorded, took copious notes, and listed mentor perceptions and themes on a white board for all study participants to see. A consensus was reached by mentors and researchers as to the common themes of the conversation regarding strengths, weaknesses, opportunities, threats, barriers, challenges, successes, and mentoring processes that occurred throughout the course in an effort to illuminate local perspectives in rich detail (Creswell, 2009). Final themes from both focus groups were shared with mentors via e-mail providing them an opportunity to verify or add to the findings. All mentors provided clarification and verification on the developed themes.

Data analysis process

According to Creswell (2014) the challenge in a convergent mixed methods design is how to converge or merge the data. This mixed methods study combined information from qualitative and quantitative data and used a side by side comparison of both the qualitative and quantitative results. Researchers then combined the data into a matrix that resulted in convergent inference where the study's two strands of data (qualitative and quantitative) informed each other.

Researchers used individual student scores from the pre and post-tests of the PAMI to determine the comparative effectiveness of each mentor before and after the mentoring experience and mentoring course (Jackson, 2009). Researchers also used open-ended data from information supplied by mentors to make an interpretation of the meaning of the data (Creswell, 2009; Rossman and Rallis, 1998). Qualitative information was gained from the focus group results. After collecting data from the mentors, the video-taped focus groups were transcribed and researchers found patterns and differences among the mentors to derive-specific methods and strategies lending themselves toward best practices for mentoring programs.

The qualitative data analysis followed the six-step generic approach recommended by Creswell (2009), and involved first, organizing and preparing the data by transcribing the video-taped focus group session, sorting, and categorizing the data; second, reading through all the data to reflect its overall meaning; third, coding the data; fourth, using the coding process to generate a description of the themes, people, places, and events of the study; fifth, describing those themes in a narrative passage or Table; making an interpretation of the data.

Results

As is often the case for mixed methods research the sheer volume of the data collection and analysis can make for extremely lengthy results and conclusions. The findings for PAMI Constructs 1 through 6 are the focus of the discussion in the results section of this manuscript. Each qualitative and quantitative data point for PAMI constructs 1 through 6 is explained and highlighted. Additionally, the research questions and research hypothesis are addressed.

PAMI construct 1: relationship emphasis

The first PAMI construct is relationship emphasis. This construct is described as sharing or reflecting on experiences, empathetic listening, and understanding or acceptance of the scholar. In an effort to address *RH1*, the pre/post-test PAMI relationship emphasis construct mean scores for all eight mentors were calculated, as well as the mean scores for the two male and six female mentors. The overall mean scores from the pre-test to post-test increased slightly, however, female mean scores decreased from pre to post-test (Table IV). Gains by male study participants were much higher from pre to post-test.

Focus group common themes and outcomes are detailed in Table V and address *RQ2*. It was clear that communication between mentors and scholars helped develop high quality relationships. During the focus group sessions, mentors stated that they used a combination of technological communication such as text, Skype, Facebook, and e-mail but that face-to-face was the most effective form of communication for them. Male mentors felt extremely comfortable using various technologies to communicate with scholars, but quickly came to the conclusion that face-to-face communication was most effective. Mentor 4 stated "I focussed on text and e-mail heavily in the beginning and I wish I would have placed more emphasis on face-to-face meetings sooner" (focus group, December 17, 2012). Mentor 5 agreed and stated, "face-to-face [communication] was really important but technological communication really helped support the relationship" (focus group, October 5, 2012). Mentor 3 demonstrated trust building and empathic listening by being direct with her scholars:

> On day one I told them who I was and my personal experiences and encouraged them to use me as a sounding board with anything they had concerns or questions about. It worked fairly well and we established a good relationship (focus group, October 5, 2012).

When asked how STEM played a role in the mentor relationship, Mentor 6 answered by saying that he built the mentoring relationship in part by taking (scholar's name) interest in network security and providing access to the tools (software) to help better prepare them for that field. Similarly, Mentor 1 stated "the mentoring relationship was definitely built around STEM because (scholar's name) was at a science and math magnet (school name) and we looked at job opportunities, entry level-pay, what it takes to get there" (focus group, December 17, 2012). She went on to say how she leveraged her scholar's interest in math and science to encourage interest in pursuing a college degree:

> "We looked at all the different types of programs that were available at various state universities that were [known for] math and science. There are numerous two-year, four-year degree programs and that was where we put the emphasis" (focus group, December 17, 2012).

Table IV. PAMI relationship emphasis scores, gender and overall means (*RH1*)

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	All
39/39	36/43	42/41	32/44	42/36	30/42	44/45	44/35	31/43	41.17/39.83	38.63/40.63
0	7	−1	12	−6	12	1	−9	12	−1.34	2

Table V. PAMI construct no. 1 focus group themes (*RQ1*)

PAMI construct	What worked	What needed improvement
Relationship emphasis	Communication Face-to-face contact Empathetic listening STEM interests matter	More face-to-face meetings More organized activities

Mentor 6 emphasized the importance of building relationships with scholars by "show [ing] him how relationships are so important because that can be the best way to find a job or to get a connection – through relationships […]. the course materials also helped me in building relationships with my scholar" (focus group, October 5, 2012).

Finally, mentors were asked during the focus groups how the course and mentoring experience impacted their mentoring abilities. Overwhelmingly, female mentors felt as though they knew and understood how to build high quality relationships prior to taking the course and the mentoring experience.

Taking both qualitative and quantitative findings and creating a side by side comparison resulted in a matrix of convergent themes that addressed *RQ2* including: first, constant communication, sharing and reflecting on experiences, and empathetic listening were crucial to a positive mentoring experience; second, female mentors created mentoring relationships more easily than their male counterparts and realized early on that communication, sharing and reflecting on experiences and empathetic listening were the keys to success. Male mentors started the mentoring relationship by trying to use a variety of technology mediated communication such as text, e-mail and Facebook, but quickly realized that building quality relationships required face-to-face meetings; third, STEM interests of the scholar helped build deeper relationships and both male and female mentors perceived that more STEM based-events, STEM based field-trips and organized events would have helped in the relationship emphasis; fourth, quantitative results revealed that males became better relationship builders over the course of the mentoring experience and when asked about this during the last focus group, males perceived that the mentor training during the course and the mentoring experience helped them in this regard. Females on the other hand did not believe this to be the case and felt as though they were good at relationship building prior to the mentoring experience. During the last focus group Mentor 8 stated, "I had a number of female role models early in my life, from my mom to my teachers to my summer camp counselors. So I felt as though I could build relationships with my scholar and that I knew how to do that prior to ever taking this course" (focus group, December 17, 2012).

PAMI construct 2: information emphasis

The second PAMI construct is information emphasis and mentors who demonstrate effectiveness in this construct should share facts about career, education, plans, and progress. In relationship emphasis, comments should be made regarding the use of information and the information should be tailored, accurate, and sufficient. To address *RH1* pre and post-test scores from the PAMI were recorded. Table VI shows that the mean PAMI pre-test scores in the area of information emphasis are lower than the mean of the PAMI post-test scores. This construct represents the largest gain for male mentors between pre/post-test scores as well as the second largest total gain for all mentors.

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	All
30/33	32/39	21/34	22/38	34/27	37/47	39/36	27/26	29/42	30.50/32.50	30.25/35
3	7	13	16	−7	10	−3	−1	13	2	4.75

Table VI. PAMI information emphasis scores, gender and overall means (*RH1*)

RQ2 was addressed by analyzing themes from focus groups. Focus group common themes and outcomes can be seen in Table VII below. All mentors felt strongly that understanding the background of the scholar and career exploration were both very important. Mentor 7 utilized information to help tailor the message to her scholar about his career, education, plans, and progress, "We went to different places in his neighborhood, went to the library. I showed him how to open a library account, how to talk to the librarian, how to talk to people about a job" (focus group, October 5, 2012). Mentor 6 discussed defining educational goals with his scholars and said:

> I had that conversation with my mentees, I asked them what they wanted to accomplish educationally. So, we started there. We went over college requirements, scholarships, and the application process and the course materials provided me a good start for doing this […] (focus group, October 5, 2012).

Regarding a face-to-face mentoring event that was part of the course titled "College Go Week," Mentor 3 said it "was really helpful by allowing us to go on the various college web sites" (focus group, December 17, 2012). She went on to say, "we went to see a little bit about the application and what things he needed to have in place in order to have that ready to go when he was ready to submit (his application) as a senior" (focus group, December 17, 2012).

RQ2 was addressed by creating a matrix of themes for the information emphasis PAMI construct by comparing qualitative and quantitative data. Those themes included: first, all mentors felt strongly that providing facts about career and education opportunities to scholars was very important and led to goal setting and strategic planning on behalf of the scholars. Second, all mentors believed that asking probing questions about educational and career goals resulted in helping assist scholars in achieving those goals. Third, mentors felt as though the mentoring course did a good job of helping them prepare for the information emphasis construct and they wanted even more formal opportunities to help guide mentors to reach career and educational goals.

PAMI construct 3: facilitative focus

According to Cohen (2008) effective mentors must demonstrate the ability to explore interests, abilities, ideas, and beliefs of those they mentor. In addition, mentors should present other views and attainable objectives so that decisions can be made by the scholar regarding careers, training, and education. Table VIII shows the mean PAMI

Table VII. PAMI construct no. 2 focus group themes (*RQ1*)

PAMI Construct	Successes	Improvements
Information Emphasis	Understanding the career & education needs of scholars Career exploration	Finding more information on scholarships Mock interviews

Table VIII. PAMI facilitative focus scores, gender and overall means (*RH1*)

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	All
21/24	16/26	16/23	18/23	22/21	12/21	22/26	19/24	15/22	19.30/24	18.25/23.50
3	10	7	5	−1	9	4	5	7	4.7	5.25

pre-test scores in the area of facilitative focus and helps answer *RQ1*. As in nearly all of the PAMI constructs, the overall post-test was higher than the pre-test in the area of facilitative focus and the overall increase between male and female mentors was closer in this construct than in the other five constructs. Additionally, this area represents the largest gain for female mentors between pre/post-test scores as well as the largest total gain for all mentors.

To address *RQ1*, qualitative data were gathered and analyzed by conducting two focus groups. As a result, mentors clearly indicated that the facilitative focus PAMI construct was very important and a lively discussion ensued during the focus groups. Mentor 2 stated, "I had no idea how to really facilitate mentees before taking this course and participating in this mentoring experience […]. I did a lot of "telling" to begin the mentoring relationship, but soon realized I better do some facilitating so that scholars could make their own decision about their futures […]" (focus group, December 17, 2012). Mentor 6 perceived that:

> this is a tricky because young kids think they already know what they want, but sometimes they don't have the knowledge to get there […]. it was important for me to never judge the dreams and aspirations of my mentee; but to serve as a coach to help them realize those dreams […].for me that is difficult because I've lived life and know the pitfalls […].watching a mentee make their own decisions, whether right or wrong, is all part of the process I guess? (focus group, October 5, 2012).

Mentors also believed that course curriculum and group events centered on career and education exploration were very helpful in developing their skills as mentors in the facilitative focus. Table IX displays focus group themes:

To address *RQ2* common themes from both qualitative and quantitative research were developed. Those themes included: first, the monthly events on educational and career exploration followed by opportunities for discussion and one-to-one counseling were very helpful to help mentors gain skills in the area of facilitation. Second, making sure that scholars had been listened to, articulated vision and plans for the future, and were autonomous in decision making.

PAMI construct 4: confrontive focus

The fourth PAMI construct is confrontive focus. This construct identifies mentors who are effective in giving insight into counter-productive strategies and behaviors. Cohen (2008) believes that mentors should be respectful of scholar decisions and actions regarding their career but should confront them with reality whenever possible. In addition to these characteristics mentors should also evaluate the need and capacity to change scholar behaviors.

In an effort to address *RH1*, the pre/post-test PAMI confrontive focus construct mean scores for all eight mentors were calculated. Table X shows that the overall mean scores on PAMI pre-test in the area of confrontive focus were slightly lower than the

PAMI construct	Successes	Improvements
Facilitative focus	Events on educational and career exploration followed by discussion Learning to listen and letting mentor make own decisions	Informing scholars on their choices Better listeners and support mentee decisions

Table IX. PAMI construct no. 3 focus group themes (RQ*1*) overall mean scores for the PAMI post-test. However, female mean scores decreased significantly from pre-test to post-test, although at about half the rate of the increase in pre-post PAMI test for males.

Focus group common themes and outcomes are detailed in Table XI and address *RQ1*. In terms of focus group themes, mentor 1 thought that in order to gain insight into her scholar's counter-productive behavior "it would have been nice to meet at their school with the counselors there" (focus group, December 17, 2012). Mentor 3 respected her scholar's decision to pursue engineering as a career but the "STEM career blueprint provided information about grades and that was something that I wasn't quite sure how I could ask […] He said he was doing well now but he wasn't at the beginning of high school" (focus group, December 17, 2012). Mentors all agreed that they addressed the counter-productive behaviors of their scholars such as business etiquette, appropriate behavior while utilizing social media, technology, poor grades in school, and the importance proper grammar. It is important to note that these counter-productive behaviors were addressed, but not necessarily changed, as that is not the purpose of the PAMI.

Mentors offered insight into scholar actions that they thought were hampering them and challenged capacity to change, but mostly in a positive way. Mentor 7 described a situation where her scholar "thought that he could not step out beyond what he knew – that beyond this there are other resources and other ways to go" (focus group, December 17, 2012). Additionally, she stated, "you might be a crack swimmer but doing that you might meet the person who introduces you to the next job or the mentor that helps you get on at (urban university)" (focus group, December 17, 2012).

To address *RQ2*, both qualitative and quantitative findings were compared creating a side by side examination resulting in a matrix of convergent themes including: first, being positive with scholars regardless of the issues facing them is helpful. Females scored significantly higher on the PAMI pre-test than did males and they seemed to understand early on that being positive was the most productive way to confront counter-productive strategies and behaviors revealed by scholars. Males were more likely to confront issues, but often this confrontation was perceived as negative by the scholar. Second, all mentors felt that during the limited time they had with their

Table X. PAMI confrontive focus scores, gender and overall means (*RH1*)

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	Overall
40/39	41/41	32/29	32/42	39/29	25/34	43/45	42/37	28.5/38	41.17/36.60	36.75/37
−1	0	−3	10	−10	9	−2	−5	9.0	−4.57	0.25

Table XI. PAMI construct no. 4 focus group themes (*RQ1*)

PAMI construct	What worked	What needed improvement
Confrontive focus	Being positive with scholars (very important even when confronting counter-productive behaviors)	Scheduling conflicts Missed meetings by scholars (time issues were a barrier) Need help from others (meeting with teachers, parents and counselors would have been helpful)

scholars, they needed to use that time to discuss positive issues and not address or confront negative issues. Third, help from others with insight into the scholar would have helped mentors better understand the counter-productive behaviors that scholars were exhibiting.

PAMI construct 5: mentor model

This PAMI construct encompasses effective mentors who disclose life experiences as a true role model to enrich the mentoring relationship. High-quality mentor modeling involves mentors taking risks, sharing their own experiences, and overcoming difficulties encountered along the way to a successful career, and constitutes the mentor model.

In an effort to address *RH1*, the pre/post-test PAMI mentor model construct mean scores for all eight mentors were calculated. Table XII shows that the mean PAMI pre-test scores in the mentor model construct were higher than the mean of the PAMI post-test scores, and this was the only PAMI construct where this happened. Overall female post-test PAMI mean scores were lower than pre-test scores, but only slightly. Male scores reflected a very slight increase from pre-test PAMI to post-test PAMI.

When asked how she set mentoring goals with her scholars, Mentor 5 stated, "I used a combination of prescriptive and developmental strategies. I started out by asking them what their overall goals were and then for each meeting I tried to have a set things that we were going to do" (focus group, October 5, 2012). Mentor 5 went on to say, "that's how I preferred to approach modeling both professional and personal experiences, and it really worked." Mentor 8 personalized the mentoring relationship by:

> Get[ting] on my mentee's level. He was initially uptight when I would go to mentor. I would mentor after work and be dressed-up and his parent thought I was a school counselor. I had to relate to him and his experience by remembering back when I was in high school and struggled with certain subjects. Once I was able to do that and open up about that, both scholars were more comfortable with mentoring and me (focus group, December 17, 2012).

Mentor 2 shared that "moving forward I would share more personal information" about herself (focus group, December 17, 2012). She went on to say; "talking about her life experiences helped to personalize the mentoring relationship and helped to make it stronger" (focus group, October 5, 2012). Table XIII depicts the PAMI mentor model construct themes and addresses *RQ1*.

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	Overall
22/22	22/20	22/21	21/24	18/17	20/20	22/25	24/19	20.5/22	21.66/20.66	21.37/21
0	−2	−1	3	−1	0	3	−5	1.5	−1.0	−0.37

Table XII. PAMI mentor model scores, gender and overall means (*RH1*)

PAMI construct	Successes	Improvements
Mentor model	Shared STEM experiences	Fully trusting scholar

Table XIII. PAMI construct no. 5 focus group themes (*RQ1*)

In an effort to address *RQ2*, both qualitative and quantitative findings were analyzed creating a side by side comparison resulting in a matrix of convergent themes that included: first, the area of mentor modeling was perceived the easiest for both male and female mentors as it required mentors to tell their "professional stories" that all of them were very proud to reveal; second, sharing and disclosing personal experiences with scholars was helpful and often personalized the mentoring relationship, however, frequency and honesty of communication between mentors and scholars was very important for success. However, all mentors believed that mentoring at risk youth was more difficult than they realized and admitted they may have overestimated competence in this construct.

PAMI construct 6: employee (student) vision

PAMI construct 6, employee (student) vision, encompasses effective mentors who assist the scholar in critically thinking about their future. Mentors help them to see their personal and career potential. Additionally, effective mentors in this construct initiate change and assist in negotiating transitions in their scholar's lives.

Table XIV shows that the mean PAMI pre-test scores in the area of student vision were lower than the mean of the PAMI post-test scores. This table also addresses *RH1*.

Table XV reveals the common themes of focus group participants for PAMI construct six and addresses *RQ1*. Mentor 7 challenged her scholar's perceptions of college stating, "we also talked about the fact that if you are in an engineering program, you are going to have to take freshman English and so it was not going to be everything that you like – math and science" (focus group, December 17, 2012). Mentor 7 went on to say that her scholar would "still have to put some sentences together and do that part well" (focus group, December 17, 2012). In addition, Mentor 6 stated, "I had to paint a realistic picture about what it really took to get through a STEM degree program […]. I let him know that a 2.5 GPA and C's in algebra were not going to cut it." Mentor 6 also discussed the process of getting into college, the process of getting a STEM job and the expectations of keeping that job. He did that by hosting his scholar for a "shadowing day" at his workplace. (focus group, December 17, 2012).

Helping his scholar utilize critical thinking skills about his future, Mentor 4 utilized his business background to assist his scholar. "One of my mentees was looking for a job. He had been to a couple of interviews and I was able to give him a lot of advice

Table XIV. PAMI construct no. 6: employee (student) vision scores, gender and overall means (*RH1*)

Mentor pre-/post-test scores and change								Mean		
1	2	3	4	5	6	7	8	Male $n=2$	Female $n=6$	Overall
29/28	27/32	24/27	29/33	30/20	14/28	34/34	27/23	16.5/30.50	28.50/27.33	26.75/28.12
−1	5	3	4	−10	14	0	−4	12	−1.34	1.37

Table XV. PAMI construct no. 6 focus group themes (*RQ1*)

PAMI construct	Successes	Improvements
Student vision	Worked logistically on path to college	Explaining realistic goals

about how to prepare and he was very excited about that" (focus group, October 5, 2012). Trying to prompt critical thinking about his future, Mentor 7 said:

> We went to the library and looked up in books the outlook for the next so many years for a job (occupational index) and also (signed up for a library card). He did not have a library card and the library was literally five minutes from his house and he was never in the library. He just thought that he could just look everything up on the internet and look at whatever he wanted. He did not know you could look at a book. Then, I could not get him out of the library! He checked out some books on resumes and wrote a resume that he is using for (to apply for) positions. (focus group, December 17, 2012).

In an effort to address *RQ2*, both qualitative and quantitative findings were analyzed creating a side by side comparison resulting in a matrix of convergent themes. Those themes included: first, all mentors worked with scholars to paint a clear picture of what it would take to get to college and/or the workplace, and the monthly events helped with this, second, male mentors in particular, used a variety of techniques to help scholars understand the reality of pathways to STEM careers and those included job shadowing, lengthy discussions about the academic expectations for STEM majors in college, and providing a clear understanding about what the STEM workplace expectations are for STEM professionals. The monthly events sponsored as a result of the mentoring course, as well as the course content on developmental mentoring helped all mentors in this PAMI construct.

Discussion, recommendations and future research

The findings and results of this study enhance the evidence base relating to STEM mentoring, on which there was a dearth of previous studies. Researchers have concentrated primarily on mentoring but few have investigated the concept of STEM mentoring program best practices. The results of this study provide a multidimensional look at STEM mentoring programs based on the PAMI constructs. In terms of hypothesis testing for *RH1*, the alternative hypothesis was supported based on pre-test and post-test results of the six PAMI constructs. Overall, the mean scores for all mentors on the PAMI post-test were higher than scores on the PAMI pre-test, and therefore the null hypothesis was rejected. *RQ1* was addressed during two focus group interviews and the opportunity for mentors to respond to common themes developed by researchers based on those focus groups.

Based on the convergent themes that emerged from examining a side by side matrix of results from *RH1* and *RQ1*, *RQ2* was answered. It became clear that three overarching themes touched on all PAMI constructs. The themes of communication, information, and gender differences permeated all aspects of the six PAMI constructs and are discussed below.

Communication

A common theme that touched on all PAMI constructs was that communication with scholars was crucial to success. Specifically, communication impacted the relationship emphasis, the facilitative focus, the confrontive focus, and mentor modeling, however, it was important in the information emphasis as well. Regardless of PAMI construct, spending time with the scholars both in person and using social networking technologies was important. This mattered especially to female mentors who perceived success at building STEM mentoring relationships and were more likely to want to participate in both group and structured activities and to spend time with scholars. To facilitate communication, STEM mentor program developers should design both structured and group STEM focussed activities, events, and outings to assist STEM mentors in building strong relationships with mentees. STEM mentoring program developers should also realize that there are many ways to communicate and create a sense of togetherness with at-risk youth utilizing both face-to-face and technological forms of communication, and that it is possible that female mentors will feel as though they possess strong communication skills that lead to high-quality relationships prior to the mentoring experience.

STEM mentoring programs wishing to recruit mentors who share and reflect on experiences, implement empathetic listening, and understand and accept their counterparts, should understand the importance of communication and this notion is supported by research from Ismail and Jui (2014). Male mentors reported difficulty in communicating with scholars who preferred text and e-mail communication only. Mentors who felt that they were compatible with their scholars, often because of a common interest in STEM, perceived a stronger connection and all mentors indicated that they built trust by always being there for their scholar to rely upon, finding out about their scholars background, and effectively communicating with them, which supports research by Fox *et al.*, (2010).

STEM mentoring programs may also want to be aware of the motivational needs of mentors. All mentors in this study perceived the opportunity to help and encourage scholars interested in STEM fields succeed and prepare them for college as being important. STEM mentoring programs should provide opportunities for face-to-face meetings and structured events in order to address the needs of mentors. When matching mentors with scholars, programs may also want to consider the STEM interests of scholars because STEM mentors felt that being able to build the mentoring relationship around a STEM theme produced a stronger bond. When both the mentor and scholar had similar STEM interests the mentors felt more comfortable in helping scholars achieve career and academic goals. The majority of mentors utilized a combination of prescriptive and developmental approaches (Morrow and Styles, 1995; Rhodes, 2005) to their STEM mentoring relationship and the mentoring course was helpful in getting mentors to understand these concepts.

Information

A second overarching theme that also applied to all PAMI constructs was that information was crucial to success. Both mentors and scholars craved information about the academic and professional aspects of STEM majors and jobs. The mentors used the developmental mentoring aspects from the course (see the Appendix) and asked many probing questions of scholars. They built trust with scholars by disclosing their own STEM experiences as university students and as STEM professionals. They listened intently and trusted scholars to disclose to them so they could help scholars set both academic and professional goals.

STEM mentors who were more successful at confronting scholars were more likely to discuss poor grades, inform scholars on bad judgment, and let scholars know when they were wasting their mentor's time. However, it was also important for mentors to understand that confrontation should be professional and positive, and the female mentors in this study seemed to understand this better than their male counterparts, who sometimes were perceived as negatively confronting issues by scholars. Supporting previous work by Cohen (2003) and Rhodes (2005), results of this study confirmed that STEM mentor program developers should seek out mentors who are willing to not only provide information to scholars, but to confront and challenge their them in a positive way.

Finally, it is important that STEM mentors actively listen to scholars and ensure that they know and understand what their vision is for a future in STEM. Once this vision is established the very best mentors will paint a clear picture of what it takes both academically and professionally to succeed in a STEM career. Mentors and scholars felt that regularly scheduled events should provide useful information about STEM careers, academic requirements for those careers, and pathways to reach the aforementioned vision. This externally provided information coupled with information from the mentor who had experienced the academic and professional rigors of a STEM career really helped with scholar visioning.

Gender differences

It was clear from the beginning of this pilot that female and male mentors had unique strengths, weaknesses, barriers, and struggles with the mentoring process. Most interesting was the finding that female mentors scored lower in pre/post-test results than males. Two female mentors scored lower on all PAMI post-test constructs than pre-test constructs. Male mentors on the other hand scored higher on each PAMI construct post-test and the overall change from pre to post-tests for males was significantly higher than female mentors.

PAMI construct 5: mentor model, was the only instance of an overall mean score that decreased from the PAMI pre- to the post-test. Consequently, participant perceptions of their mentoring abilities decreased from the start to the end of the class and mentoring experience. These results indicate that mentors initially overestimated their abilities in this construct. The qualitative data supported this result and male and female mentors suggested during focus groups that mentoring at risk, urban youth was much more of a challenge than they originally thought when agreeing to be a part of the program. Results also revealed that female mentors perceived that they created mentoring relationships more easily than their male counterparts, however, they scored lower on the post-test results indicating that neither the mentoring course nor the mentoring experience contributed to this finding. Males however, perceived that the course and the mentoring experience helped them grow and get better as mentors.

Finally, it was clear that the two males in this study were more likely than female mentors to help and confront scholars by using a variety of techniques considered to be developmental in nature. Females perceived that they had a "natural ability" to develop relationships, provide information, and gain the trust of scholars by using a variety of communication techniques; and they used a positive tone whenever possible. Males on the other hand more often used a confrontational tone with scholars.

In terms of future research, it is important to remember that this was a small pilot with a small sample and that findings should not be generalized. Additionally, it is important to understand that apparent gender differences, although stark in this study, may not actually result from gender, but from other characteristics of each individual mentor. Future research should replicate this study with a larger scale that could help establish whether results could be generalized to the broad STEM population. Certainly, future research could use a larger and deeper demographic group than at risk, urban youth. This pilot study also had an uneven balance between female (6) and male mentors (2), and a larger sample would likely provide more balance between male and female study participants. Five of the eight mentors studied were minorities, however, additional studies are needed to capture a more ethnically diverse and larger cross section of the population in order to adequately assess impact on minority mentors. Future studies should investigate how to more thoroughly capture the unique attitudes and concerns of minority mentors and at risk youth. Additionally, the differences between male and female STEM mentors should be studied along with the barriers each confronts and how those barriers are overcome.

A longitudinal study that tracks both mentors and scholars could be of great merit. If a primary school longitudinal study were conducted it could follow mentees as they progress from elementary school through college and into the workplace. This would inform researchers as to whether duration, type, and intensity of STEM mentoring made a difference in STEM pipelines.

Although the literature review found that mentors who utilized a developmental approach to mentoring were most effective, future studies could investigate the effectiveness of both types of approaches (prescriptive and developmental) in a STEM mentoring context. Finally, qualitative, quantitative and mixed methods studies designed using each of the PAMI constructs should be developed to determine how the constructs apply in STEM mentoring contexts.

In conclusion, it is important to continue to conduct research on mentoring in general and STEM mentoring programs in particular. Mentoring has been found to be a useful tool for at risk, urban youth, but research needs to be undertaken to clarify additional insights on the design, development, and delivery of high quality, high impact, STEM Mentoring programs.

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(The Appendix follows overleaf.)

Appendix

STEM Mentoring and Leadership Development
Fall 2012: Syllabus: OLS 39900/58100 (1.0 cr.)
STEM section
With Lab (1.0-6.0 cr.)
Please note that this **STEM** class meets face-to-face three times. Syllabus subject to change.

Page 1: instructors, contact information, office hours, writing center, mandatory meetings, STEM course information, student outcomes
Page 2: suggested text, prerequisites, grades, policies and procedures
Page 3: STEM course schedule, STEM course schedule detail

Mandatory meeting dates/location
Wednesday, August 31, 2012, Room SL 165. Mandatory STEM mentor training session: room to be determined at either Noon – 3:00pm or 5:30-8:30 p.m. (choose one)
Wednesday, September 7, 2012, Room SL 165. Mandatory STEM mentor/scholar meet and greet: room to be determined at 5:30 p.m.
Saturday, December 17, 2012, Room SL 165. Mandatory end of course wrap-up: room to be determined at 10 a.m.-12:30 p.m.

Course information
All course communication via the web
Catalog Description: in this special section of the STEM Mentoring and Leadership Development course, students will become STEM mentors and be assigned a scholar. As a part of the course they will be assigned students in area urban high schools in and around Indianapolis. STEM mentors will help in developing scholar confidence, independence, creativity, and communication skills to insure academic and personal success in relation to STEM for all scholars. Mentors will reflect on their mentoring experience and will be required to document each meeting with their student. Each mentor can choose their variable credit depending on how many students they wish to mentor and the time involved (i.e. 2 students = 2 credit hours). This class will be taken along with Mentoring and Leadership Development (1-6 cr.).
Textbook: no textbook required. (see resources folder for required readings and pre-approved list of Mentoring and Leadership Books for the Leadership and Mentoring assignment).

Student outcomes
Understand the role of STEM mentors and define mentorship best practices. Develop skills for communication and relationship building with scholars. Demonstrate understanding of diversity and the range of traditions, values, and experiences that impact scholars and their academic progress. Recognize the relationships between the roles of leaders, mentors, and supervisors to better prepare scholars for future careers or advanced degrees. Facilitate academic and personal success for all scholars.
Text: Dubrin, A. J. (2005). *Coaching and Mentoring Skills*, ISBN: 0130922226, Prentice Hall, NJ.
Prerequisites: instructor approval
Grades: students who earn below a 70 percent must retake this course to meet the OLS BS Core degree requirement to earn a grade of C or higher in all required Core OLS courses. Final letter grades will be determined by overall percentage as follows:

A 90-100 percent
B 80-89 percent
C 70-79 percent
F 69 percent and below

University, department, and course policies and procedures

Administrative Withdrawal: a basic requirement of this course is that you will participate in all activities and conscientiously complete writing and reading assignments. Keep in touch with course instructor if you are unable to attend any class or complete an assignment on time. If you miss any class meetings without contacting me, you will be administratively withdrawn from this section. Our class meets once; thus if you miss this you may be withdrawn. Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal will take place after the full refund period, and if you are administratively withdrawn from the course you will not be eligible for a tuition refund. If you have questions about the administrative withdrawal policy at any point during the semester, please contact me.

Attendance Requirement for OLS 39900: OLS 39900 students are required to attend all mandatory on-campus orientation and mentor trainings. Students are expected to make every effort to attend any meetings arranged online or in person during the semester. Students who will miss mentor sessions must notify the facilitator at the earliest possible time and inform the STEM coordinator of changes to the mentoring schedule.

Incomplete Grades: "The grade of Incomplete used on the final grade report indicates that a substantial portion of the course work has been satisfactorily but not entirely completed as of the end of the semester. The grade of Incomplete may be given only when the completed portion of the student's work in the course is of passing quality. Should the faculty member agree to assign a grade of Incomplete, he or she also has the right to set a specific date (up to one year) by which all unfinished work must be completed. Upon submission of the completed work, the faculty member files a Removal of Incomplete form with the Office of the Registrar. Please note that by agreeing to assign a grade of Incomplete (I), the instructor is not required to give the student a year to finish the work. The instructor has the right to set a shorter-term deadline as deemed appropriate. If the student has not satisfactorily completed the work by the deadline established by the instructor, the instructor should send a Removal of Incomplete form to the Office of the Registrar with the appropriate grade on the completed work. If the work has not been completed and a grade assigned within a year from the end of the semester in which the Incomplete was awarded, the Office of the Registrar will automatically change the grade to an F."

For additional information, please view the origin of the text above in the Bulletin or the Registrar's web site: Please note that all students are expected to complete his/her work. As noted by the Academic Handbook: "Honesty requires that any ideas or materials taken from another source for either written or oral use must be fully acknowledged. Offering the work of someone else, as one's own, is plagiarism. The language or ideas thus taken from another may range from isolated formulas, sentences, or paragraphs to entire papers copied from books, periodicals, speeches, or the writings of other students. The offering of materials assembled or collected by others in the form of projects or collections without acknowledgement also is considered plagiarism. Any student who fails to give credit for ideas or materials taken from another source is guilty of plagiarism."

Course schedule	Due	Activity	Points
Week 1: 8/22-8/28	August 25, 2012	During the first week log on to Oncourse and post a discussion forum introducing yourself to the class and respond to at least two classmate's posts	50
Week 2: 8/29-9/4	August 31, 2012	This week you will attend one session on campus. We will be covering STEM mentoring strategies and best practices. We will ask you to take the principles of adult mentoring inventory (PAMI). We will give you an understanding of what is expected of you throughout the semester and in your role as a STEM mentor	200
Week 3: 9/5-9/11	September 7, 2012	Attend the STEM mentor/scholar meet and greet at 5:30pm, meet the scholar you will be mentoring. This session will last no more than 2 hours. Fill out STEM "blueprint" at stemworksindiana.com	200
Week 4: 9/12-9/18	September 11, 2012	Complete first mentor log online. Contact time with scholar per your credit hour election. Post to the Forums on OnCourse	50
Week 5: 9/19-9/25	September 25, 2012	Complete STEM mentor log online. Contact time with scholar per your credit hour election. Post to the STEM Forums on OnCourse	15
Week 6: 9/26-10/2	October 2, 2012		15
Week 7: 10/3-10/9	October 9, 2012		15
Week 8: 10/10-10/16	October 16, 2012		15
Week 9: 10/17-10/23	October 23, 2012		15
Week 10: 10/24-10/30	October 30, 2012		15
Week 11: 10/31-11/6	November 6, 2012		15
Week 12: 11/7-11/13	November 13, 2012		15
Week 13: 11/14-11/20	November 20, 2012		15
Week 14: 11/21-11/20	November 27, 2012	Begin STEM research project due 12/11. Complete STEM mentor log online. Contact time with scholar per your credit hour election. Post to the STEM Forums on OnCourse	15
Week 15: 11/28-12/4	December 4, 2012	Complete STEM mentor log online. Contact time with scholar per your credit hour election. Post to the STEM Forums on OnCourse	15
Week 16: 12/5-12/11	December 11, 2012	Complete your final STEM project and turn in via Oncourse under Assignments 2 link. Upload under final STEM research paper and name the file lastname_finalresearchpaper.docx	135
	December 17, 2012	Attend final STEM mentoring session	200
		Total points	1,000

Table AI.
STEM Mentoring and Leadership Development

About the authors

Dr Charles Feldhaus is the Chair of Graduate Programs and an Associate Professor of Organizational Leadership and Supervision in the Department of Technology Leadership and Communication for the Purdue School of Engineering and Technology at Indiana University Purdue University Indianapolis (IUPUI). He also serves as the Co-Director for the IUPUI STEM Education Research Institute (SERI). He spent 20 years as a P-12 Educator, a Principal, and a District Office Administrator before receiving his Doctorate in educational administration from the University of Louisville in 1999. Undergraduate work was completed at the University of Southwestern Louisiana in 1979 and the MS in secondary education was awarded in 1985 from Indiana University. Research interests include leadership in P-16 STEM education; STEM workforce development and leadership; P-16 STEM teacher preparation; STEM discipline-based educational research, coaching and mentoring, and organizational ethics. Dr Charles Feldhaus is the corresponding author and can be contacted at: cfeldhau@iupui.edu

Kristin Bentrem, MS, was a Graduate Assistant with the MS in Technology degree program offered by the Purdue School of Engineering and Technology at IUPUI at the time of this research. She is currently a Doctoral Candidate in the PhD program in Higher Education Administration at IUPUI. She is also a Research Assistant with the Division of Student Affairs at IUPUI.