Honing Interpersonal Communication Skills for Difficult Situations: Evidence for the Effectiveness of an Online Instructional Resource

Ms. Amy Elizabeth Dawson, Arizona State University

Amy Dawson, M.A., is a doctoral student in the Counseling Psychology program at Arizona State University. Amy is also a research assistant for the NSF funded CareerWISE project housed at ASU.

Prof. Bianca L. Bernstein, Arizona State University

Bianca L. Bernstein, Ph.D. is Professor of Counseling and Counseling Psychology in the College of Letters and Sciences at Arizona State University. Dr. Bernstein is Principal Investigator of the CareerWISE research program, supported by the National Science Foundation since 2006. Her over 250 publications and presentations and over $3.6 M in external support have focused on the application of psychological science to the career advancement of women and underrepresented minorities and the development of effective learning environments for graduate education.She is a AAAS fellow and has won a number of awards for her work on equity, inclusiveness and mentoring of students and faculty. Dr. Bernstein holds a bachelor's in psychology from the University of California at Berkeley and graduate degrees in Counseling Psychology from the University of California at Santa Barbara.

Ms. Kerrie Wilkins, Arizona State University

Kerrie Wilkins is a doctoral candidate in the Counseling Psychology program at Arizona State University. She received her Bachelor of Science in Experimental Psychology from the University of South Carolina Upstate and a Masters of Arts in Education from Arizona State University. Kerrie is a lead Research Assistant on the CareerWISE research project. Her research interest lies at the intersectionality between measurement, scale development and vocational psychology with the primary aim of promoting career advancement and persistence among women in STEM and cross cultural groups.

Dr. Jennifer M Bekki, Arizona State University

Honing Interpersonal Communication Skills for Difficult Situations: Evidence for the Effectiveness of an Online Instructional Resource

Introduction

Interpersonal communication skills can be conceptualized as understanding the dynamics and applying the principles of receiving and sending verbal and nonverbal messages.[1] Across career and educational fields, interpersonal communication skills are considered fundamental to success. Effective communication has been associated empirically with higher quality academic accomplishments, better professional and personal relationships, and increased physical wellbeing.[2] Further, it has been identified as an important 21st century skill and one of the primary attributes that employers desire in new hires, including the science, technology, engineering, and mathematics (STEM) fields.[3] In STEM careers and graduate programs, team research and interdisciplinary groups are increasingly common. Such groups require collaboration facilitated by strong interpersonal communication skills. In engineering specifically, teamwork and communication are two of the five principal skills necessary for success.[4]

Aside from the employment sector, communication skills are critical to the success of graduate students in STEM fields. Such skills are particularly salient in the advisor-advisee relationship. In one study, a lack of advisor support and guidance was offered as a contributing motive for 86% of the women who chose to leave science.[5] Moreover, researchers have shown that women who completed their graduate program late were three times more likely to report having unsatisfactory advising experiences than women who received their degrees on time.[6] Late completers reported that their advisors thwarted their timely degree completion, while early degree completers expressed that advisors were instrumental to program advancement.[6] Feelings of being disregarded, disrespected, neglected, having lower professional self-efficacy, and a lack of knowledge about how to successfully progress through a degree program are commonly reported among graduate students who express discontent with their advisor relationship.[7] Researchers have established that graduate students who were allowed to provide their advisors feedback expressed greater satisfaction with their advising relationship, highlighting the importance of developing the central components of interpersonal communication, namely the capacity to receive and respond to feedback, in the graduate school setting.[8] Moreover, graduate students are more likely to complete their graduate program when they have the capacity to express their needs. [9, 10, 11]

Despite the recognized importance of interpersonal communication skills, the topic is rarely built into higher education programs. One promising option for increasing access to a communication curriculum is to offer it in an online format. Recent evidence that 6.7 million students in the U.S. are enrolled in online courses suggests that students are comfortable and familiar with online education.[12] The teaching of professional skills has been applied via online formats for the training of salespeople,[13] medical professionals, and particularly for members of the military in terms of leadership, multicultural understanding, and communication skills.[14, 15,

[16, 17] However, empirical studies of teaching and learning non-technical skills, such as communication skills, via electronic means have been limited. The purpose of the study reported here is to examine the effectiveness of the *Career*WISE online learning resource designed to provide instruction on increasing interpersonal communication skills for women in physical science and engineering doctoral programs.

Great efforts have been made at the institutional level to promote gender equity in STEM careers and academic programs, such as NSF's ADVANCE programs, which provides grants to examine and attend to institutional practices that may differentially affect women in STEM. The *Career*WISE program in this study takes a unique approach to the issue of gender disparity by working to increase personal resilience skills, including a new curriculum in interpersonal communication skills. The online training program focuses on understanding the gendered and environmental aspects of common problematic situations in graduate school and aims to prepare women for moments when they experience doubts or conflicts. The focus on skill building techniques for women is not intended to suggest that women are the catalyst for the problems they encounter or that they are inadequate but rather recognizes the everyday situations that women face, especially in fields where they are outnumbered.

The paper presents a portion of results from a randomized controlled trial (RCT) in which the intervention was interaction with new resources on communication skills that extend an online resilience-training program, *Career*WISE. The results presented here focus on study participants' ability to describe how they would apply interpersonal communication skills to scenarios pertinent to graduate students in science and engineering. The study measures are detailed, along with the rubrics created for evaluating responses. Reliability and validity information for the rubrics is also provided.

Methods

Intervention Description

*Career*WISE (careerwise.asu.edu) was built by an interdisciplinary group of investigators at Arizona State University and is personalized to women in STEM fields. The curriculum is based on psychological theory and research, specifically social cognitive career theory (SCCT);[18] and coping resilience.[19, 20, 21, 22, 23] The results of focus groups[24] and individual interviews[25] as well as research on women's experiences in science and engineering fields were used to develop program content and to create examples relevant to women in STEM programs.[26, 27, 5, 28, 29, 30, 31, 32, 33, 34, 35, 36]

*Career*WISE was designed to develop problem-solving skills for four challenges commonly experienced by women in STEM[23, 24]: difficulties with advisors, work-life balance issues, navigating climates that may be unfriendly to women, and unexpected delays and setbacks in research. *Career*WISE features over 50 educational modules on topics such as problem-solving, thinking styles, stress triggers, perspective-taking, and interpersonal communication styles, along with almost 200 video accounts of graduate experiences and strategies employed by successful women in STEM fields. A previous RCT[37] found that the

curriculum influenced three variables theoretically associated with persistence, specifically, problem solving knowledge, resilience, and coping efficacy.[23]

Due to the lack of instruction on interpersonal communication skills for students in science and engineering fields, *Career*WISE was recently broadened to include a curriculum on interpersonal communication. Via written material and interactive video simulations, the communication curriculum aims to elucidate the different and complex elements that comprise a productive interpersonal interaction. The curriculum utilizes authentic examples from female graduate students in STEM in order to help students improve their skills and effectively relay their message in such a way as to promote their academic and professional success. The new curriculum includes written modules that are designed to help students obtain communication skills that are essential for managing difficult situations, such as, Planning Your Message, Active Listening, Expressing Yourself, and Receiving and Responding to Feedback.[38]

This content also includes interactive video simulations that provide training in three critical interpersonal communication skills of active listening,[39] receiving and responding to feedback,[40] and self-expression.[41] Each simulation presents a scenario that research has shown to be problematic for women in science and engineering graduate programs, such as interacting with a critical and impatient advisor, dealing with conflicting commitments to a partner and research, and managing undermining and gender biased feedback. The interactive video simulations are designed to help users practice what they learned via a "build your own adventure" model that provides users with multiple opportunities to decide how to respond to a common interpersonal communication situation in a graduate school setting. Video scenarios are presented to the user, after which the user is given three options to choose from; one option is not likely to result in a successful outcome, another option is very likely to result in a successful outcome, and a third alternative is a neutral response.[42] Following the user's response selection, a narrator provides feedback and another video demonstrates how the chosen response influences the interpersonal exchange.[43] The sequence of the video, response choice, feedback and subsequent response selection continues until the correct responses are chosen.[42] The RCT from which results reported here were obtained was recently conducted to assess the efficacy of the new interpersonal communication portion of *Career*WISE.

Instrumentation

Research has established that skills and tasks that require higher order thinking are best assessed using open-ended performance based instruments.[44, 45] Moreover, it is useful to give learners realistic scenarios to respond to when assessing learning objectives that are difficult to capture via traditional assessment formats [44, 46, 47] A requirement of such open ended instruments is that they include a valid scoring rubric that can be used to train scorers who will evaluate learner responses. The current study aimed to evaluate the effectiveness of *Career*WISE in promoting effective interpersonal communication skills. Therefore, a scenario based, open-ended measure was selected. The rubric development process and the rubric's effectiveness will be discussed below.

The Assessment of Interpersonal Communication Skills (AICS) instrument consists of two questions. As part of the RCT, participants were asked to respond to two short open-ended

scenarios, each depicting a commonly faced interpersonal communication scenario for women graduate students. The first asked each participant to imagine that she had received critical feedback from her advisor, and the second asked the student to put herself in a situation in which she was confused by a comment made by her advisor about another student. These situations drew on the skills taught in two specific communication modules, namely, Receiving and Responding to Feedback and Active Listening for Question 1 and Question 2, respectively. The AICS measured participant ability to illustrate how they would apply interpersonal communication skills in each scenario. Responses were scored via the use of a rubric by trained raters. The prompts for the two items are shown in Table 1. The context for the two scenarios used in the AICS was based on previous research by an interdisciplinary team of graduate students and faculty including members from the fields of counseling psychology, industrial engineering, and education technology. In constructing the scenarios, special efforts were made to ensure that the scenarios were relevant across multiple disciplines.

Table 1.

Prompts for each of the ACIS Questions.

ACIS Item Number	**Prompt**
Question 1	Krishna's advisor recently gave her some critical feedback. In a chance encounter with her in the hallway, he told Krishna that she had gotten her work in too late to be included in the manuscript. *Imagine you are Krishna. In the space below, describe how you would interpret (i.e., think about) your advisor's feedback. Also, cite examples of interpretations you would use (i.e., exact thoughts).*
Question 2	Dr. Chung, Isabella's advisor, recently asked her to mentor Collin, a senior undergraduate student who joined their research lab. Isabella decides to meet with Dr. Chung to discuss Collin's progress. Dr. Chung shares the following with Isabella, "It would be great for Collin to handle the upcoming data collection. I'm not sure, though, if he is going to fit as well as the undergraduate researcher in our lab this past semester." Isabella feels confused by her advisor's comment. *Imagine you are Isabella. In the space below, describe how you would clarify with Dr. Chung his comment so you have a better understanding of what you should do as a result. Also, cite specific examples of statements or questions you would use (i.e., exact quotes).*

Participant Recruitment and Demographics

The current study was comprised of 312 female doctoral students recruited from a nationwide sample of STEM doctoral programs. Specifically, women were recruited from disciplines with an underrepresentation of female STEM students. These fields included: chemical engineering, civil engineering, electrical engineering, materials science, mechanical engineering, computer science, physics, applied physics, math, applied math, chemistry, astronomy, and geological sciences. More than 50% of the participants in the sample were enrolled in engineering-specific disciplines. Participant ages ranged from 23 to 51, with a mean

age of 27.6 (SD = 3.28). Participants self-identified as Anglo American (60%), Asian American (26.4 %), African American (3.8%), Hispanic/Latino American (9.2%). Twenty-six percent of the sample identified as international students, and a similar percentage (24.2%) identified English as their second language.

Protocol

To evaluate the effectiveness of the new interpersonal communication focused content, a randomized controlled trial was conducted, as it provides the strongest evidence for evaluating the effectiveness of an intervention[49] An essential component of randomized controlled trials is that participants are randomly split between treatment and control groups. Control group(s) are not exposed to the intervention, while treatment group(s) are. Following treatment group exposure, differentiations between the treatment and control groups are explored in an effort to measure the effectiveness of the intervention. In the RCT reported here, participants were divided into two treatment groups, one that had access to the entire *Career*WISE website, one that had access to all site content with the exception of the interactive video simulations, and a wait-list control group (WLC). The WLC group was given access to the entire online resource at a later time, which allowed those participants to also gain any associated positive impacts.

Outcome measures for the RCT included self-reported knowledge of and self-efficacy in interpersonal communication skills and ability to apply key interpersonal communication skills. Comparisons based on outcome measures were made both between the two treatment groups and between each of the treatment groups and the wait-list control group. Additionally, pre-post measurements were made on the WLC group. The results presented here are related only to the AICS measure described previously. The results of the larger RCT are detailed in a forthcoming publication. The protocol, recruiting, and participant demographics are the same that were used in the broader RCT.

In total, 312 participants completed the RCT protocol. Participants completed a demographic survey and were then randomly assigned to one of the two treatment groups or the WLC group. Of protocol completers, N = 103 were in treatment group 1 (access to the written modules but not to the simulations), N = 95 were in the treatment group 2 (access to entire interpersonal communication resource [written and simulations]), and N = 114 were in the WLC group. The treatment groups were each asked to spend at least three hours exploring the material to which they had unrestricted access to during a two-week time frame. The reason that the site exploration was unconstrained (versus forcing participants to explore certain modules or simulations) was to imitate how *Career*WISE would be used in a non-experimental setting. The three hour requirement was based on an estimate that three hours was a reasonable amount of time to review the material. After completing the treatment, participants were given access to the online ACIS.

WLC group participants were initially given the ACIS approximately two weeks after they submitted the demographic survey. They were then given access to the online interpersonal communication curriculum and asked to spend at least three hours interacting with the site, in the same unconstrained manner that the treatment group used. After completing their exploration, each WLC group participant was again given access to the ACIS. After submission of the ACIS,

participation was considered complete. All participants received a $25 gift card to a prominent online retailer as compensation.

Scoring Rubric

Two scoring rubrics based on the interpersonal communication curriculum were developed to evaluate participant responses to the ACIS. The rubrics included separate coding schemes designed to measure participant ability to describe how they would apply interpersonal communication skills to Question 1 and to Question 2. For each question, participant responses were scored on a four-point scale with instructional text provided to assist raters. The coding scheme in Figure 1 is the first version of the coding scheme used to score responses to Question 1 of the ACIS.

A scoring team of doctoral students in counseling psychology participated in a rater training following initial development of the rubrics. The training was led by a counseling psychology faculty member who is an expert in interpersonal communication. The training was designed to optimize inter-rater reliability by increasing rater skill in implementing the coding schemes. Before the training session, each rater scored a set of responses, and during the session, the raters compared scores to each response. The raters each expressed their grounds for assigning the score, and the goal was to obtain consensus on the correct score for each response.

Refinements and improvements to the rubrics were incorporated based on the results of the training session. The final coding schemes used to score responses to Question 1 and Question 2 of the ACIS are shown in Figure 2 and Figure 3, respectively.

1	2	3	4
One of the following conditions is met: Krishna provides a behavior instead of a thought (e.g. "I would ask for clarification" OR "I would say, we never discussed a deadline.") OR ▪ Krishna does not answer the question.	**One** of the following conditions is met: ▪ Krishna provides a thought that indicates passive acceptance of the feedback (e.g. "I guess he's right." OR "Oh well, it's too late now.") OR ▪ Krishna provides a *negative* thought that is likely to decrease her feelings of competence and self-worth. (e.g. "I would wonder- How could I be so absent minded?..." OR "I would think- Looks like I messed up again…") OR "I would think – I'm scared, I really needed that publication." OR ▪ Krishna provides a defensive thought. (e.g. "I would think- What deadline?" OR "We never discussed a deadline") OR ▪ Krishna provides a thought that does not meet the criteria for a score of 3 or 4.	**One** of the following conditions is met: ▪ Krishna provides a *positive* thought that indicates that she is trying to regain control (e.g. I would think about other places I could submit my work" OR "Next time I'll be sure to get my work in on time.") OR ▪ Krishna provides a thought that indicates an intention to clarify her understanding of the feedback (e.g." I would think that I would need to ask him to clarify." OR "I wonder what he meant by that.") OR ▪ Krishna provides a thought that compares this feedback with past experiences involving this advisor and others (e.g. "He's usually more accommodating." OR "I don't usually get my work in late" OR "I would remind myself of the positive feedback I've received about my writing in the past.") OR ▪ Krishna provides a thought that indicates that she is considering her advisor's experiences (i.e. stressors, pressures, deadlines, tenure, etc.) and acceptance of the fact that she cannot change or control him. (e.g. "He's probably under pressure to submit the article for his tenure packet" OR "Wow, he must be stressed.")	**Two** of the following conditions are met: ▪ Krishna provides a *positive* thought that indicates that she is trying to regain control (e.g. I would think about other places I could submit my work" OR "Next time I'll be sure to get my work in on time.") OR ▪ Krishna provides a thought that indicates an intention to clarify her understanding of the feedback (e.g. I would think that I would need to ask him to clarify." OR "I wonder what he meant by that.") OR ▪ Krishna provides a thought that compares this feedback with past experiences involving this advisor and others ("e.g. He's usually more accommodating." OR "I don't usually get my work in late" OR "I would remind myself of the positive feedback I've received about my writing in the past.") OR ▪ Krishna provides a thought that indicates that she is considering her advisor's experiences (i.e. stressors, pressures, deadlines, tenure, etc.) and acceptance of the fact that she cannot change or control him. (e.g. "He's probably under pressure to submit the article for his tenure packet" OR "Wow, he must be stressed.")
SCORE, Q1: _____/4			

Figure 1: First draft rubric used for scoring Question 1

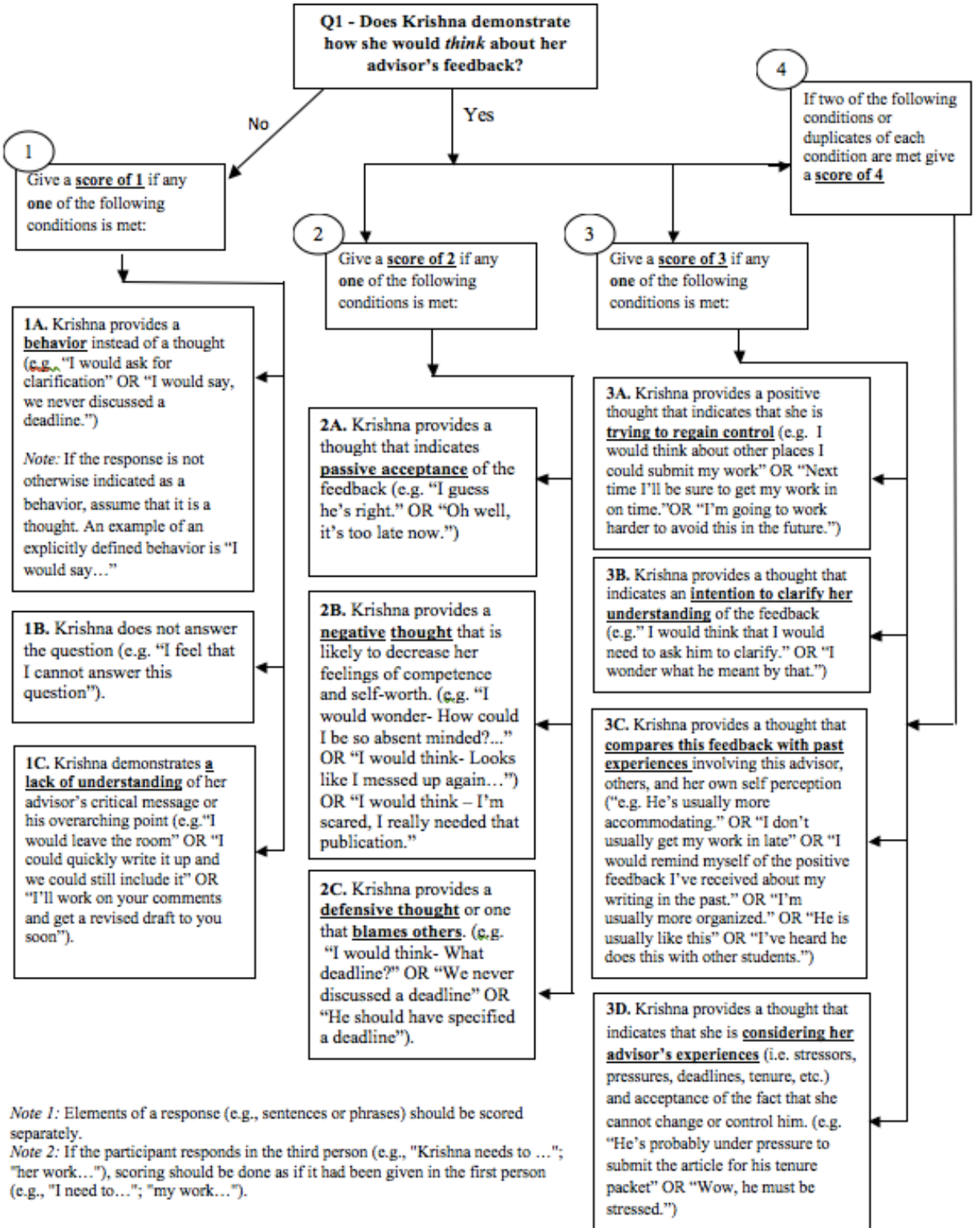
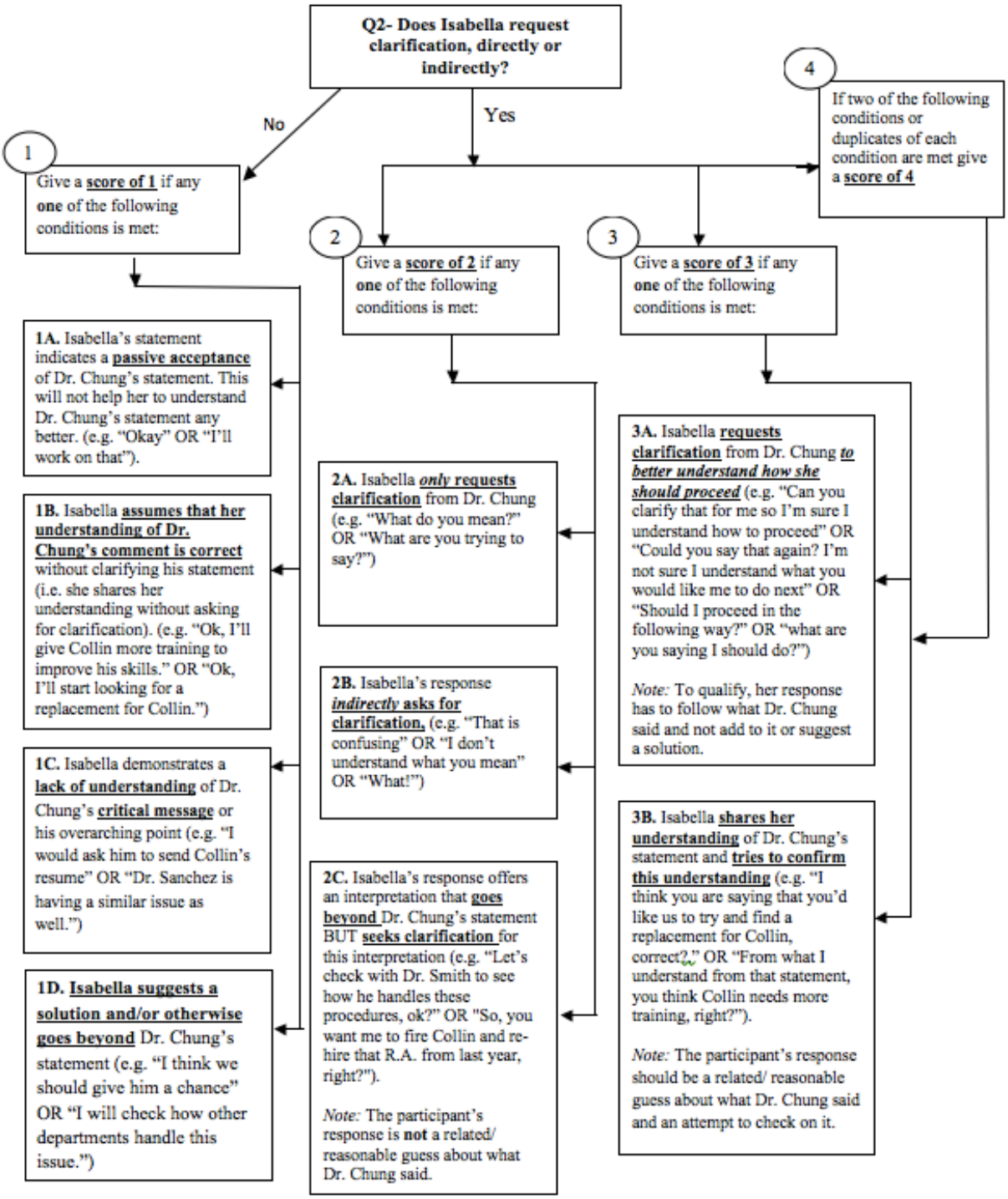


Figure 2: Final draft of the rubric used for scoring Question 1.



Note 1: Elements of a response (e.g., sentences or phrases) should be scored separately.
Note 2: If the participant responds in the third person (e.g., "Krishna needs to …"; "her work…"), scoring should be done as if it had been given in the first person (e.g., "I need to…"; "my work…").

Figure 3: Final draft of the rubric used for scoring Question 2.

Assessment of Rubric Adequacy

The updated rubrics were used to score 75 randomly selected responses to Question 1 and 75 randomly selected responses to Question 2. Raters were blind as to what group the responses were from as well as to which responses for Question 1 and Question 2 came from the same participant.

Consensus-based inter-rater reliability measures the degree of agreement on how to assign scores according to the rubric.[50] Scores by multiple raters are considered equivalent if the inter-rater reliability is high enough for a large enough sample of the data. In such instances, only one scorer is required to rate remaining data (versus having multiple scorers look at 100% of the data). Krippendorff's α was used to calculate inter-rater reliability.[51] Krippendorff[51] recommends the inclusion of at least 70 responses to determine whether $\alpha \geq 0.80$ with a significance level of 0.05 when a rubric has four scoring outcomes. Therefore, we made a selection of 75 responses for each question.

The inter-rater reliability, α, was calculated separately for Question 1 and Question 2 using the KALPHA macro in SPSS.[52] A 95% confidence interval surrounding α for each of the questions on the ACIS was obtained. The original scoring team consisted of three doctoral students. Upon completion of scoring 75 random items from Question 1 and Question 2, the resulting confidence intervals around α for Question 1 were 95% CI [0.57, 0.77] and 95% CI [0.38, 0.58] for Question 2 for all three raters. When examining the rater dyad combinations, it was clear that two of the raters were in stronger agreement with each other than with the third rater; confidence intervals around α were 95% CI [0.79, 0.94] for Question 1 and 95% CI [0.45, 0.75] for Question 2 for raters 1 and 2. Due to the lack of consensus between the three raters and the presence of consensus between raters 1 and 2, the final scoring team only comprised of these two raters . Another scorer training session was conducted and raters 1 and 2 rescored another set of 75 random items. The resulting confidence intervals around α for Question 1 were 95% CI [0.95, 1.00] and 95% CI [0.73, 0.94] for Question 2. Krippendorff recommends an α of at least 0.80 for drawing more than tentative conclusions.[52] This value is included in the confidence interval surrounding the α values for both Question 1 and Question 2. Based on the outcome of the inter-rater reliability and the validity evaluations by the domain expert during training, the rubrics were deemed suitable for measuring the knowledge of and scenario-based application of interpersonal problem solving skills. The remainder of the responses on the ACIS to be scored were randomly divided amongst the trained scorers. The average score was calculated across all original raters for data that had previously been scored for the training session. Responses to Question 1 and Question 2 were analyzed separately.

Results

A one-way ANOVA comparing the treatment groups to the wait-list control group was performed for each of the two responses (Question 1 and Question 2). Follow-up comparisons identified differences between each of the three groups for each scenario. ANOVA results for significance and effect sizes (η^2) are given in Table 2 along with summary statistics for each analysis. The statistical significance of both ANOVA analyses and associated effect sizes provide evidence that treatment group membership had a statistically significant impact on the

measure designed to capture participant ability to describe how they would apply interpersonal communication skills [F (1, 4) = 10.13, p = 0.00] for the first question and [F (1, 4) = 5.22, p = 0.01] for the second question.

Table 2: Summary of ANOVA analyses comparing qualitative responses between treatments and wait-list control groups.

Question	Group	Mean	SD	Range (Min, Max)	ANOVA F-test	p value	η^2	Cohen's d
1	Written Only (N=103)	2.73	0.87	(1,4)	10.13	.000*	0.06	.51
	Written & Sim. (N=95)	2.97	0.94	(1,4)				
	WLC (N=114)	2.43	0.83	(1,4)				
2	Written Only (N=103)	2.76	0.91	(1,4)	05.22	.01*	0.03	.35
	Written & Sim. (N=95)	3.18	0.84	(1,4)				
	WLC (N=114)	2.96	0.92	(1,4)				

Note: Asterisks indicate statistical significance $p < .05$. Points possible for Q1 and Q2 = 4.

Table 3: Summary results of the pairwise comparison between the treatment and waitlist control (WLC) groups qualitative scores

	Group 1	Group 2	Mean Difference (grp 1 - grp2)	Std. Error	p value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Question 1	T1Writ	T2 W+Sim	-.246*	.124	.049	-.490	-.001
	T1Writ	T3WLC	.298*	.119	.013	.064	.532
	T2 W+Sim	T3WLC	.544*	.122	.000	.305	.783
Question 2	T1Writ	T2 W+Sim	-.413*	.128	.001	-.665	-.162
	T1Writ	T3WLC	-.194	.122	.114	-.434	.047
	T2 W+Sim	T3WLC	.220	.125	.080	-.027	.466

Note: Asterisks indicate statistical significance $p < .05$. T1Writ = treatment group 1 (access to written modules only); T2 = treatment group 2 (access to written modules and simulations); T3 = Wait-list control treatment group (access to written modules and simulations).

Follow-up pairwise comparisons (see Table 3) revealed that, for the first scenario, members of the treatment group that had access to the online resource including both the interactive simulations and written content were better able to describe how they would apply interpersonal communication skills to a relevant scenario than members of the wait list control group (M group difference = .544), p = 0.00. Similarly, members of the treatment group that had access to written content only (e.g., no access to interactive simulations) also scored significantly

better than members of the wait-list control group (*M* group difference = .298), $p = 0.013$. Finally, for both the first and second scenarios, members of the treatment group that had access to only written content scored statistically better on the measure (*M* group difference = -.246), $p = 0.049$ for scenario 1 and (*M* group difference = -.413), $p = 0.001$ for scenario 2 than members of the treatment group that had access to both the written content and the interactive simulations.

Discussion

This paper provides evidence to support that the *Career*WISE online learning environment can positively impact the ability to apply the interpersonal communication skills that are fundamental to navigating academic programs among women doctoral students in science and engineering. Interpersonal communication skills are critical to the relationship between a student and an advisor, to the functioning of research teams, and to obtaining employment, and they are linked to persistence amongst graduate students.[3, 4, 8, 9, 10, 11] However, these important skills are rarely taught in graduate programs in the sciences and engineering. An online, individualized resource focusing on communication should be beneficial for graduate students preparing for occasions when they experience complicated or everyday interpersonal scenarios.

A subset of results from a randomized controlled trial were presented that illustrate the assessment of interpersonal communication skills. The rubric used to score participant responses in the study was shown to have satisfactory inter-rater reliability and validity. The 95% confidence interval around the inter-rater reliability for Question 1 of the scoring rubric was [0.95, 1.00], and for Question 2 was [0.73, 0.94].

Comparisons between treatment and WLC participants revealed that participants in both the written-only and the written plus simulation treatment groups were shown to have a statistically superior ability to describe how they would apply interpersonal communication skills ($p < 0.01$). Further support for the results was provided via the positive effect sizes (Cohen's *d*, .51 and .35 for Questions 1 and 2 respectively) associated with the analysis comparing the two treatment and the wait-list control groups. Other studies assessing the application of skills report similar medium effect sizes.[55] More specifically, Katz et al. (2008)[56] reported a 0.42 effect size (using Cohen's *d*) when comparing the scores between first year and second year undergraduate students using a scenario-based assessment. Furthermore, in a previous study by Bekki and colleagues (2014) assessing the ability of participants to apply problem-solving skills via open-ended questions, we obtained comparable medium effect sizes (Cohen's *d*, 0.508 and 0.583)[60] .

Subsequent pairwise comparisons revealed that members of the treatment group that had access to written content only (e.g., no access to interactive simulations) also scored significantly better than members of the wait-list control group ($p = 0.013$). These results provide further support for the effectiveness of the *Career*WISE online learning environment in improving interpersonal communication skills as assessed here.

A more surprising result is that, for both the first and second scenarios, members of the treatment group that had access to only written content scored statistically better on the measure

(p = 0.049 for scenario 1 and p = 0.001 for scenario 2) than members of the treatment group that had access to both the interactive simulations and the written content. While we cannot be sure of the reason for these results, we suggest that the interactive video simulations may have had interpersonal communication cues that were more complex to interpret than the written materials. Participants were only required to spend three hours exploring the *Career*WISE website content. Participants who only had time to interact with the simulations in the time allotted would have missed the benefit of the written lessons that are designed to augment the interactive simulations. It may be that more time spent exploring the entire website is necessary to provide enough variance to detect differences between the treatment groups.

Limitations and Future Work

No study is without limitations, including this one. We acknowledge that the assessments used in this study do not evaluate whether the communication skills taught by the online resource are transferable to real life settings. The results were based on participant responses to only two scenarios on one occasion of assessment, which took place immediately following interaction with the intervention. A follow up post-test would provide a more comprehensive evaluation of whether participants maintained the skills. Furthermore, the examples included in *Career*WISE are designed to appeal to female doctoral students in science and engineering fields. Further research would be necessary to determine whether other members of the population (e.g., male doctoral students in science and engineering) benefit from the content and find it relevant to their own doctoral experiences.

In the future, alternative assessments will be used to determine the intervention's effectiveness. For example, in addition to observations of interpersonal interactions, follow up studies would ask participants to provide a self-reported indication of the transferability of skills learned from interaction with the *Career*WISE program to their actual academic environment. Additionally, further analyses will reveal the trajectories of participants through the *Career*WISE online learning environment (e.g., in what order participants visited various pages within the online program, and for how long they were on each page) and examine how such patterns are related to learning. Future analyses will aim to present a clearer understanding of *how* participants learned the interpersonal communication skills vs. the current study's examination of *whether* they learned them.

This material is based upon work supported by the National Science Foundation under Grant No. 0910384. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Bibliographic Information

1. Klein, C., DeRouin, R. E., & Salas, E. (2006). Uncovering workplace interpersonal skills: A review, framework, and research agenda. In G. P. Hodgkinson & J. K. Ford (Eds.), *International review of industrial and organizational psychology* (Vol. 21, pp. 80-126). New York: WIley & Sons, Ltd.
2. National Research Council. (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. Washington, DC: The National Academies Press.
3. National Association of Colleges and Employers. (2012). *Job Outlook 2013*. Bethlehem, PA: NACE. Retrieved from: http://www.unco.edu/careers/assets/documents/NACEJobOutlookNov2013.pdf
4. Passow, J.H. (2012). Which ABET competencies do engineering graduates find most important in their work. *Journal of Engineering Education*, 101, 95-118.
5. Preston, A.E. (2004). *Leaving science: Occupational exit from science careers*. New York, NY: Russell Sage Foundation.
6. Maher, M. A., Ford, M. E., & Thompson, C. M. (2004). Degree progress of women doctoral students: Factors that constrain, facilitate, and differentiate. *The Review of Higher Education*, *27*(3), 385-408.
7. Schlosser, L. Z., Knox, S., Moskovitz, A. R., & Hill, C. E. (2003). A qualitative examination of graduate advising relationships: The advisee perspective. *Journal of Counseling Psychology, 50*(2), 178.
8. McCuen, R.H., Akar, G., Gifford, I.A., & Srikantaiah, D. (2009). Recommendations for improving graduate adviser-advisee communication. *Journal of Professional Issues in Engineering Education and Practice, 135*(4), 153-160.
9. Lovitts, B. E. (2001). L*eaving the ivory tower: The causes and consequences of departure from doctoral study*. Lanham, MD: Rowman & Littlefield.
10. Raoul Tan, T. L. & Potocnik, D. (2006). Are you experienced? Junior scientists should make the most of opportunities to develop skills outside the laboratory." *EMBO Reports.* 7, pp. 961–964.
11. Tomazou, E. M., & Powell, G. T. (2007). Look who's talking too: Graduates developing skills through communication. *Nature Reviews Genetics*, 8, 724-726.
12. Allen, E.I., and J. Seaman. (2013). *Changing course: Ten tears of tracking online education in the United States*. Babson Survey Research Group and Quahog Research Group, LLC.
13. Kass, A., R. Burke, E. Blevis, and M. Williamson. (1994). Constructing learning environments for complex social skills. *The Journal of the Learning Sciences* no: 3 (4): 387-427.
14. Campbell, J. C., J. Hays, M. Core, M. Birch, M. Bosack, and R.E. Clark. (2011). Interpersonal and leadership skills: Using virtual humans to teach new officers. In *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC).*
15. Johnson,W.L. (2010). Using immersive simulations to develop intercultural competence. *Culture and Computing*. Berlin: Springer J Verlag.
16. Zbylut, M. L., K.A. Metcalf, J.M. Kim, R.W. Hill, Sc. Rocher, and C. Vowels. (2007). Army excellence in leadership (AXL): A multimedia approach to building tacit knowledge and cultural reasoning. *Technical Report 1194*. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, retrieved January, 2014 http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA461995.
17. Zbylut, M. L. and J.N. Ward, J. N. (2005). "Developing interpersonal abilities with interactive vignettes." In *Proceedings for the Army Science Conference*.
18. Lent, R.W., S.D. Brown, and G. Hackett. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior* no. 45(1): 79-123.
19. Carver, C.S., M.F. Scheier, and J.K. Weintraub. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology* no. 56(2): 267-283.
20. Lazarus, R.S. and S. Folkman. (1984). *Stress, Appraisal and Coping.* New York: Springer.
21. Maddi, S.R. (2005). On hardiness and other pathways to resilience. *American Psychologist* no. 60(3): 261-262.
22. Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist* no. 56(3): 227-238.
23. Bernstein, B. L. (2011). Managing barriers and building supports in science and engineering doctoral programs: Conceptual underpinnings for a new online training program for women. *Journal of Women and Minorities in Science and Engineering, 17*(1), 29-50.
24. Bernstein, B. L. & Russo, N. F. (2008). Explaining too few women in academic science and engineering careers: A psychosocial perspective. In M. Paludi (Ed.), Series on *The psychology of women at work: Challenges and solutions for our female workforce.* Vol 2: *Obstacles and the identity juggle* (pp. 1 – 33). Westport, CN: Praeger Press.

25. Anderson-Rowland, M.R., Bernstein, B.L. Russo, N.F. (2007). Encouragers and discouragers for domestic and international women in doctoral programs in engineering and computer science. In *Proceedings of the 2007 American Society for Engineering Education Conference*.
26. Etzkowitz, H., C. Kemelgor, and B. Uzzi. (2000). *Athena Unbound: The Advancement of Women in Science and Technology*. Cambridge: Cambridge University Press.
27. Fox, M.F. (2001). Women, science, and academia: graduate education and careers. *Gender & Society* no. 15(5): 654-666.
28. Rosser, S.V. (2004). *The Science Glass Ceiling: Academic Women Scientists and the Struggle to Succeed.* New York: Routledge.
29. Rosser, S.V. (2012). *Breaking into the Lab: Engineering Progress for Women in Science.* New York: New York University Press.
30. Sonnert, G. and G. Holton, G.(1995). *Who Succeeds in Science?*: *The Gender Dimension.* New Brunswick, NJ: Rutgers University Press.
31. Valian, V. (1998). *Why So Slow: Advancement of Women.* Boston, MA: MIT Press.
32. Valian, V. (2007). Women at the top in science—And elsewhere. In *Why Aren't More Women in Science? Top Researchers Debate the Evidence*, edited by S.J. Ceci and W.W. Williams. Washington, DC: American Psychological Association.
33. Settles, I.H., L.M. Cortina, J. Malley, and A.J. Stewart. (2006). The climate for women in academic science: The good, the bad, and the changeable. *Psychology of Women Quarterly* no. 30(1): 47-58.
34. Seymour, E., and N.M. Hewitt. (1997). *Talking About Leaving: Why Undergraduates leave the Sciences.* Boulder, CO: Westview.
35. Wao, H.O., R.S. Lee. and K.M. Borman. (2010). Climate for retention to graduation: A mixed methods investigation of student perceptions of engineering departments and programs. *Journal of Women and Minorities in Science and Engineering* no. 16(4): 293-318.
36. Xie, Y. and K.A. Shauman. (2003). *Women in Science: Career Processes and Outcomes.* Cambridge, MA: Harvard University Press.
37. Bekki, J. M., Smith, M. L., Bernstein, B. L., & Harrison, C. (2013). Effects of an online personal resilience training program for women in STEM doctoral programs. *Journal of Women and Minorities in Science and Engineering*, 19 (1), 17 – 35.
38. Prime, D., Bernstein, B. L, Way, A., Hita, L. C., Liddell, T. M., Sarma, A. R., Bekki, J. M. (2013). Development of an internet-delivered communication curriculum for graduate women in STEM. Proceedings of the American Society for Engineering Education, M543.
39. Rogers, C. R. (1951) *Client-Centered Therapy*. Boston: Houghton-Mifflin.
40. Winne, P. H., & Butler, D. L. (1994). Student cognition in learning from teaching. In T. Husen & T. Postlewaite (Eds.), *International Encyclopedia of Education* (2nd ed., pp. 5738-5745). Oxford, UK: Pergamon.
41. Alberti, R. E., & Emmons, M.L. 1970. *Your Perfect Right--a Guide to Assertive Behavior*, *Impact*: San Luis Obispo, California
42. Bernstein, B.L., Bekki, J.M., Wilkins, K.A., & Harrison, C. J. (2014). Analysis of Instructional Support Elements for an Online, Educational Simulation on Active Listening. Manuscript submitted for publication to the *Journal of Computing in Higher Education.*
43. Azarnoush, B., Bekki, J. M., Runger, G., Bernstein, B. L, & Atkinson, R.K. (2013). An Associative Based Approach to Analyzing an Online Learning Environment, *Proceedings of the American Society for Engineering Education*, T217.
44. Jonsson, A. and G. Svingby. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational Research Review* no. 2: 130-144.
45. Sankar, C., V. Varma, and P. Raju. (2008). Use of case studies in engineering education: Assessment of changes in cognitive skills. *Journal of Professional Issues in Engineering Education and Practice* no. 134 (3): 287-296.
46. Kranov, A.A., C. Hauser, R. Olsen, and L. Girardeau. (2008). A direct method for teaching and assessing professional skills in engineering programs. In *Proceedings of the American Society for Engineering Education Annual Conference*.
47. McMartin, F., A. McKenna, and K. Youssefi. (2000). Scenario assignments as assessment tools for undergraduate engineering education. *IEEE Transactions on Education* no. 43 (2): 111-119.
48. Arlin, M. (1976). "Casual priority of social desirability over self-concept: A cross-lagged correlation analysis." *Journal of Personality and Social Psychology* no. 33(3): 267-272.

49. U.S. Department of Education. (2009). Identifying and Implementing Educational Practices Supported By Rigorous Evidence: A User Friendly Guide, retrieved January, 2014 from http://www.ed.gov/rschstat/research/pubs/rigorousevid/guide_pg5.html.
50. Stemler, S.E. (2004). A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. *Practical Assessment, Research and Evaluation* no. 9(4), accessed May 25, 2012, from http://PAREonline.net/getvn.asp?v=9andn=4.
51. Krippendorf, K. (2004). *Content Analysis: An Introduction to Its Methodology, Second Edition.* California: Sage Publications.
52. Hayes, A., and K. Krippendorff. (2007). Answering the call for a standard reliability measure for coding data. *Communication Methods and Measures* no. 1(1): 77-89.
53. Moskal, B.M., J.A. Leydens, and M.J. Pavelich. (2002). Validity, reliability and the assessment of engineering education. *Journal of Engineering Education* no. 91(3): 351-354.
54. Stemler, S.E. (2004). A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. *Practical Assessment, Research and Evaluation* no. 9(4), accessed May 25, 2012, from http://PAREonline.net/getvn.asp?v=9andn=4.
55. Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences.* New Jersey: Lawrence Erlbaum Associates.
56. Katz, I. R., N. Elliot, Y. Attali, D. Scharf, D. Powers, H. Huey, and V. Briller. (2008). *The Assessment of Information Literacy: A Case Study*. ETS Research Report No. RR-08-03. Princeton, NJ: Educational Testing Service.
57. Gijbels, D., F. Dochy, P. Van den Bossche, and M. Segers. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research* no. 75(1): 27-61.
58. Dochy, F., M. Segers, P. Van den Bossche, and D. Gijbels. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction* no. 13(5): 533-568.
59. Tsaushu, M., T. Tal, O. Sagy, Y. Kali, S. Gepstein, and D. Zilberstein. (2012). Peer learning and support of technology in an undergraduate biology course to enhance deep learning. *Life Sciences Education* no. 11(4): 402-412.
60. Bekki, J.M., Bernstein, B.L. Fabert, N.S., Gildar, N.J., & Way, A. (2014). Efficacy of an online resource for teaching interpersonal problem solving skills to women graduate students in engineering, *Advances in Engineering Education*.