Cyber Value and Interest Development: Assessment of a STEM Career Intervention for High School Students

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Abstract

The authors empirically examine the effectiveness of an intervention program designed to facilitate interest in cyber science among high school students (N = 60). Pretest-posttest and mediation designs were used to model self-report data that were collected at pre-camp, during a cyber-related task at mid-camp, and at post-camp. An analysis of covariance (ANCOVA) revealed a significant two-way interaction whereby perceived value of cyber science increased from pretest to posttest for girls but decreased for boys. Situational interest was also found to mediate the relationship between Investigative vocational interest type and cyber science self-efficacy. Implications for future cyber science intervention programs as well as areas of additional research are discussed.

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Introduction

The world has seen an increase in the number of attacks on personal, governmental, and commercial computer security systems in recent years. Such a proliferation computer "hacking" has triggered a movement in the labor market toward meeting critical occupational needs in cyber security. Indeed, the U.S. Department of Labor (Bureau of Labor Statistics, 2009) anticipates a 45.3% rate of growth in computer systems design careers between 2008 and 2018. This growth rate is third only to careers in health care and management, and scientific and technical consulting. It has therefore become increasingly important that stakeholders in education and industry work toward developing the human resources needed to meet this demand. Educators recognize that in order to foster the requisite interest and technological skill needed for success in cyber science careers, it is critical that students be introduced to cyber science before they enter college. Unfortunately, addressing this human resource issue from a gender perspective may be difficult because girls appear to have lower interest in cyber-related activities than boys. This is supported by the fact that in 2007 women earned only 19% of bachelor degrees awarded in computer science; this figure represents a decline from the approximately 28% degrees awarded to women in 2003 (National Science Board, 2010). Clearly, greater efforts directed at increasing girls' interest in cyber science need to be undertaken. As a working definition of cyber science, our team characterizes the emergent discipline more broadly than some. Most definitions tend to focus on a more engineering-centric approach in which cyber science and engineering are seen as intertwined, as has been the case with almost every other emergent science. The engineering aspects and needs of cyberspace are not unimportant and are addressed by our team in other venues. Thus, cyber science requires a broader perspective that includes not only computational mathematics, computer science, and other science and engineering disciplines in an effort to use cyberinfrastructure but also the social, ethical and policy issues inherent in the human experience that is created by new and innovative technologies. Thus, cyber science manifests itself as more of a classical natural science where the 'science' is integrated throughout with what would be seen today as the liberal arts.

Perceived Value of Cyber Science

Individuals do not often develop interest in an activity unless or until they see the value the activity holds for them. Such may be the case for girls and cyber science due to the natural association with perceptions of computer science. Expectancy-value theory (EVT) (Eccles, 2005; Eccles et al., 1983) represents one model that can account for girls' cyber-related beliefs and behaviors. EVT proposes that individuals form estimates of the value and likelihood of success associated with engaging in an activity, and these estimates in turn play an important role in determining the individual's choice of activity. Eccles et al. (1983) delineated four components of task value: (a) attainment value; (b) intrinsic value; (c) utility value; and (d) cost. Attainment value represents the importance ascribed to performing well on a task while intrinsic value represents the enjoyment derived from being involved in an activity. Utility value refers to the extent to which a task is viewed as being useful for purposes of achieving other important personal, social, or occupational goals. Cost refers to the belief that more is expected to be lost than gained by engaging in a task. Cost is therefore perceived to be higher when task value is low and vice versa.

Prior research involving high school students suggests that task value predicts important academic and motivational outcomes. Zusho and Barnett (2011) found that task value was a significant positive predictor of girls' academic help-seeking behavior in both English and mathematics. Eccles and her colleagues (Eccles, Wigfield, Harold, & Blumenfeld, 1993) have shown that girls and boys place relatively equal value on mathematics, while girls additionally place greater value on reading than boys. However, while mathematics and cyber science share some characteristics in common, girls' perceptions of the value of cyber science are still not well understood due to the field's nascent status as a STEM domain.

Unfortunately, girls may view the costs associated with cyber involvement as outweighing any expected benefits. One reason for this is that computing careers are often stereotyped as being performed primarily by men. Miller and Hayward (2006) found that while girls believed more strongly than boys that men and women could perform equally well in the occupation of software engineering, the perception that men hold the majority of the jobs in the occupation was greater among girls.

Another reason why girls may view cyber science as being too costly is that the environments in which its activities are typically performed may not be construed as being conducive to the development of relationships with others. For example, research suggests that females tend to prefer goals that are pursued in the context of social relationships, such as serving one's community and helping others, while males tend to prefer agentic goals aimed at individual achievement (Diekman, Brown, Johnston, & Clark, 2010; Diekman, Clark, Johnston, Brown, & Steinberg, 2011). For girls, then, social situations provide the primary context in which competence perceptions develop, whereas individual achievement situations afford boys more frequent opportunities to infer competence.

Utility value has been shown to predict both interest and competence perceptions. In a study involving college students, participants instructed to reflect on the value of a mathematics technique reported greater situational task interest (Hulleman, Godes, Hendricks, & Harackiewicz, 2010). Perhaps more important was the additional finding that participants with lower initial performance expectations reported a greater increase in utility value as a result of an experimental manipulation than participants with high performance expectations. This is important because it suggests that girls may derive greater benefit from cyber interventions considering previously reported gender differences in this area (Carbonaro, Szafron, Cutumisu, & Schaeffer, 2010; Cheryan & Plaut, 2010). The purpose of the present study was to evaluate the efficacy of an educational intervention program called *Cyber Discovery*, which was developed with the intent of fostering interest in cyber activity among high school students. At its core, Cyber Discovery is a professional development program for high school teachers. The culmination of the program is a residential camp experience for the teachers who, together with partner university faculty, guide a student team of rising sophomores from their high school through week-long challenges involving specific disciplines such as engineering, computer science, English, history, mathematics, cryptography, and political science. It builds on a successful professional development model by engaging high school teacher teams through the challenges placed before a small team of their students.

Vocational Personality

Cyber science is not unlike any other occupational pursuit in that individual interest in and valuation of the domain can grow or recede as a function of educational and social experiences. However, it is also possible that there exist stable vocational interest types that serve to direct individuals toward certain occupations. Holland's (1997) hexagonal RIASEC model represents a prominent and influential theory of vocational personality. This model proposes that individuals choose occupations on the basis of 6 interest types: (a) Realistic; (b) Investigative; (c) Artistic; (d) Social; (e) Enterprising; and (f) Conventional. Realistic types prefer working with objects (e.g., tools) in outdoor settings, whereas Investigative types are described as intellectually curious and prefer working with ideas. Artistic types typically prefer creative endeavors while Social types prefer helping and working with others. Finally, Enterprising typically enjoy occupations that involve the use of persuasive skills (e.g., sales) and Conventional types prefer working with data in settings that require organizational skills.

Prior research suggests that these interest types begin to crystallize during the adolescent years (Tracey & Robbins, 2005) and are predictive of important career-related outcomes (e.g., Betz, Harmon, & Borgen, 1996). Cyber science should logically fall under the purview of Investigative interests given this activity, like all scientific activities, requires the application of analytical skills. Development of these vocational interests typically begins during late childhood and early adolescence when individuals are increasingly exposed to the world of work and the tasks associated with various occupations. Investigative interests have been shown to be among the most stable of these interests. Tracey and Ward (1998) found that the Holland Investigative interest type was more stable over time than each of the other five interest types in a sample of middle school students. While Investigative interests appear to be among the first to develop, all of the interest types have been shown to be quite stable throughout high school (Tracey, Robbins, & Hoffsess, 2005) and invariant across gender and ethnic groups (Gupta, Tracey, & Gore, 2008; Tracey & Robbins, 2005). As noted previously, the purpose of the present study was to determine the extent to which students' perceptions of the value of cyber science are amenable to the influence of an intervention program, referred to as the Cyber Discovery program. However, we also wished to assess the utility of Investigative interests as a predictor of students' science self-efficacy, and determine whether situational interest mediates this relationship. We discuss the Cyber Discovery program in more detail in the next section.

Cyber Discovery

Cyber Discovery was developed by collaborations among the mathematics, science, engineering, and liberal arts faculty. The primary goal of the program is to help teachers and students become better cyber-citizens who help security efforts by making them aware of the benefits and dangers of cyberspace. Faculty members from the College of Engineering and Science team up with the College of Liberal Arts to develop an engaging experience aimed at high school teachers and students, culminating in a week-long camp experience.

The Cyber Discovery program consists of a week-long residential camp, held in early June, attended by both students and teachers preceded by two Teacher Professional Development workshops held in the Spring. The workshops give the teachers exposure to the material to be presented to the students by having the university faculty team walk them through some of the projects and discussions that will be given during the regular camp. This allows the teachers to serve as an integral part of the team, concentrating less on learning the material and more on **aiding, guiding** and **observing** the students through the week-long experience.

The week-long camp is a total immersive experience for all individuals involved. Throughout the program, the university team uses a variety of media formats to present material including lectures, slides, and movies. Students are engaged with various hands-on labs, informal discussion sessions, and writing challenges. The material covers a range of interdisciplinary topics from fields such as Engineering, Mathematics, Computer Science, English, History, and Political Science. Some activities last a single day while others are week-long challenges. Overall, the curriculum is designed to fully engage the students for the entire week allowing the various skills and interests of the individual members.

During the week-long camp, each school works as a team of two teachers and six students. Participating schools are encouraged to send one teacher from a STEM discipline and one teacher from a humanities or liberal arts program. The teachers are encouraged to select student teams that balance academic disciplines with roughly half of the team having interests in science/mathematics and the other half in the traditional humanities. The leadership at the participating schools also select these students based on their personal experiences with them.

To address the difficulty of engaging students for an intense full day, a typical day is divided into various topics and incorporates various means of group interaction. The camp uses sessions that involve all participants, sessions where the schools work independently as a group, and sessions with mixed small groups where individuals are randomly assigned to help create diverse new interactions.

In developing the curriculum, the university faculty team selects topics from the various disciplines so that they blend with the content being discussed for the entire day.
The following is a sample list of the activities used throughout the camp:

Hands-On-Lab, Boe-bot: Serving to introduce basic programming concepts and notions of logic, controls, and problem solving, the Boe-bot is a robotic platform previously used extensively in the university's own freshman engineering curriculum. Being primarily hands-on, the activities involving the Boe-bot serve as a "hook" used to engage the students while demonstrating issues associated with cyber vulnerability stemming from code security, signal transmission, and programming. The initial activities involve basic concepts and autonomous navigation via sensory input but then advance to establishing a wireless connection to remotely control the robot.

Cyber Policy and Ethics: Students are presented with issues related to cyber policy and ethics from historical and philosophical positions. Faculty encourage students to critically examine their engagement with information technology and assess its impact both on classical ideas of democracy and American democracy in particular. Students are also exposed to the historical use of information technologies in domestic and international politics, and the dangers that their use poses to various historical actors. Students are encouraged to discern and apply "lessons of history" to contemporary situations today.

For example, on the day that behavior modification is discussed, a psychology professor outlines the basic concepts associated with changing a person's behavior. An historian follows with a discussion of propaganda strategies throughout the 20th century. A question posed on the topic leads students and teachers into discussions that integrate the liberal arts and sciences. Teams are then required to produce an essay addressing the question of the day.

Hands-On-Lab: Cryptography. Starting with a historical perspective on cryptography, hands-on / minds-on sessions are held each day. Faculty members from Computer Science and Mathematics lead discussions on issues in cryptography. Rather than focus on the technical college-level details of cryptography, the emphasis is on establishing answers to questions such as "*Can we share information without revealing information?*", "*What makes a problem computationally difficult?*", and "*How can public keys be used to share private information?*" Students are not only exposed to essential cryptographic concepts but also to the underlying mathematical and logical background. By discussing the mathematics behind modern cryptography, students and teachers are exposed to the important notion that our safety in cyberspace is only as strong as the state of knowledge of solving complex mathematics.

Hands-On-Lab: Architecture. Even man-made structures have an impact on cyber security, from the type of construction material used to the layout of access points to various rooms. To emphasize the relationship, Architecture faculty present background material and then encourage the students to consider the need cyber-infrastructure places on new and existing buildings. As part of the preparation for the final Cyber Challenge, the teams use 3-D modeling software (Sketch-Up) to design and construct buildings to be used to defend their territory. Initially, the students submit a draft model for which the Architecture faculty analyze and give feedback. The students then alter the model, resubmit, and due to the limited time constraint have one shot at its construction. This forces the students to consider how their designs function and what their vulnerabilities are *before* the models are ever fabricated or tested.

Cyber Treasure Hunt. Along the lines of the *National Treasure* movies, a Cyber Treasure Hunt intertwines all aspects of the academic content of the camp. This challenge requires teams to apply content that is covered in the academic sessions with social interactions. The Cyber Treasure Hunt requires students to use cryptographic skills, historical context, physical mapping, wireless communication, and general problem solving as they navigate their way through the maze of clues throughout the campus.

On the first day of the camp, each school is presented with a locked box. After performing what amounts to a brute-force attack on the box and determining the appropriate combination, the students open the box to reveal a collection of puzzles. The puzzles themselves lead to other puzzles that are scattered across the campus. These puzzles are of a nature that reflects the topics of the camp. One puzzle, for example, requires students to perform a walking Boe-bot program where each clue is presented in the form of a Boe-bot program in PBASIC and leads them to another clue in another part of the campus. Several puzzles involve using cryptographic concepts learned during the content sessions with a few required materials handed out in other lectures, including one puzzle that requires the use of a copy of the U.S. Constitution as a cipher.

Cyber Challenge. Throughout the week, activities and assignments are included as part of a week-long competition where points are awarded based on placement in each assignment. On the final day of the camp, teams participate in two final components of the competition. The "Cyber Challenge" manifests itself as a robotics competition centered on the Boe-bot, where students use the engineering and computer science knowledge acquired during the week-long activities. From a broad description, the challenge involves all teams using their Boe-bots to navigate an arena to collect marbles, while simultaneously preventing others from doing the same and defending their own collection. On the final days of the camp, the teams program their Boe-bot to work wirelessly so that each can be remotely navigated. They also use pre-made and self-designed attachments to their Boe-bots to help in the task. At the same time, the building they design is used to store and protect the marbles as they are collected. The second creative component of the final day's challenge, judged by professional writers in the region, involves having the students develop their own story-lines surrounding the overall competition.

The Present Research

Although the overarching goal of Cyber Discovery is to promote interest in cyber activity among both students and teachers, we were particularly interested in studying how female students' attitudes toward cyber activity might be affected by the program. Our hypotheses were twofold. First, we predicted that girls would report a significant increase in cyber science value as a result of participating in the camp. We did not predict a similarly significant increase for boys given that they have been found to possess high pre-existing interest in cyber science (Voyles, Fossum, & Haller, 2008). We thus expected to detect a significant time x gender interaction whereby girls' perceptions of cyber value would be higher at posttest but boys' perceived value was expected to be relatively unchanged. Second, we predicted that task engagement would mediate the relationship between vocational interest type and cyber science self-efficacy. This hypothesis was predicated on the notion that because vocational interest is believed to be a personality-type factor, it should predispose individuals to the subjective experience of interest in a vocation-related task. In turn, this situational interest should result in higher perceptions of competence in cyber activity.

Method

Participants

The sample consisted of 60 students representing 10 high schools in the southeast United States. Most participants identified as female (56.3%) while 43.7% identified as male. The majority of participants also identified as Caucasian (88.7%), while 8.5% identified as African American and 2.8% identified as multiracial. Age ranged from 16 to 19 (M = 16.66, SD = .73).

Measures

Vocational interest. We measured Investigative career interests using the Self-Directed Search-Form R (SDS) (Holland, 1994). The SDS is a 228-item measure consisting of four scales that are designed to tap vocational interests across Holland's (1997) six occupational themes. These scales include: (a) Activities (66 items); (b) Competences (66 items); (c) Occupations (84 items); and (d) Self-Estimates (12 items). The Activities scale consists of 66 dichotomously-scored items for which respondents are asked to rate the degree to which they like or dislike various vocational activities. The Competencies scale also consists of dichotomously-scored items (yes vs. no) that ask respondents to indicate their perceptions of whether they can perform certain vocational tasks competently. The Occupations scale asks participants to rate their interest in careers corresponding to each interest type (e.g., auto mechanic), while the Self-Estimates scale asks participants to rate their perceived ability in various skill domains (e.g., musical ability) using a Likert-type scale ranging from 1 (*low*) to 7 (*high*). Scale scores are summed across the 6 interest types, with higher scores indicating stronger affinity for a given vocation-related area. Scores range from 0 to 66 for the Activities scale, from 0 to 66 for the

Competencies scale, from 0 to 84 for the Occupations scale, and from 7 to 84 for the Self-Estimates scale.

Situational interest. Intrinsic situational interest was measured using the intrinsic motivation subscale of the Situation Motivation Scale (SIMS; Guay, Vallerand, & Blanchard, 2000). The SIMS is a 16-item questionnaire consisting of four, 4-item subscales that measure task-specific degrees of internal versus external motivation: (a) intrinsic motivation (e.g., "Because I think that this activity is interesting"); (b) identified regulation (e.g., "Because I am doing it for my own good"); (c) external regulation (e.g., "Because I am supposed to do it"); and (d) amotivation ("I do this activity, but I am not sure it is worth it"). Participants are asked to respond to the stem question "Why are you currently engaged in this activity?" on a Likert scale ranging from 1 (*corresponds not at all*) to 7 (*corresponds exactly*). Scores range from 4 to 28 for each scale with higher scores indicating greater motivation for the intrinsic motivation, identified regulation, and external regulation scales, and lower motivation for the amotivation scale. Guay et al.'s (2000) analyses have shown that the intrinsic motivation subscale possesses excellent internal consistency ($\alpha = .95$), and standardized factor loadings for its items range from .79 to .96. A Cronbach's alpha coefficient of .86 was obtained in the present study.

Science self-efficacy. We measured science self-efficacy using the 6-item Science Confidence subscale of the Subjective Science Attitude Change Measures (SSACM; Deemer, Smith, Thoman, & Chase, in press; Stake & Mares, 2001). The SSACM was developed with the purpose of measuring change in adolescents' perceptions of self-efficacy and intrinsic motivation. Each scale is anchored by the statement "My experiences in the program…". Participants respond to items on a Likert scale ranging from 1 (*not at all*) to 7 (*a great deal*). An example response for science confidence includes "made me feel more relaxed about learning science." For the purpose of the present study, the anchor statement was adapted to read "My experiences in this camp…". Scores range from 6 to 62, with higher scores indicating greater science self-efficacy. Cronbach's alpha coefficients of .89 for science motivation to .93 for science confidence have been obtained (Stake & Mares, 2001). A Cronbach's alpha coefficient of .94 was obtained in the present study.

Cyber value. Perceived value of cyber activities was measured at pretest and posttest using one item, "Please rate how important cyber science and technology subjects are to you currently." This item was scored on a Likert scale ranging from 1 (*not important at all*) to 7 (*very important*).

Procedure

Data were collected by camp staff at the beginning, during the middle, and at the conclusion of the camp. Because all participants were under the age of 18, informed written consent was obtained from their parents prior to the outset of data collection. Camp participants were informed that their involvement in the study was voluntary and that their responses would remain confidential and anonymous. Upon arriving at the week-long camp all participants were asked to complete a paper and pencil version of the SDS as well as an online survey consisting of a demographic questionnaire and the one-item of perceived value of STEM. To assess situational intrinsic motivation, participants were asked to complete another brief online survey while they were engaged in a cyber task midway through the camp. Participants were then asked to complete a final online survey following their last camp-related task in order to assess their attitudes toward STEM and their follow-up perceptions of the value of STEM. Participants were debriefed at the conclusion of the study and thanked for their participation.

Results

Means, standard deviations, and correlations are presented in Table 1. The effect of the cyber intervention on STEM valuation was analyzed with a 2 (gender: male vs. female) x 2 (time: pretest vs. posttest) analysis of covariance (ANCOVA) with repeated measures on the time factor. Holland Investigative type was included in the ANCOVA model as a covariate to control for the effects of vocational personality. While there was not a multivariate effect of time, Pillai's $V = .001$, $F\ (1, 24) = .02$, $p = .88$, nor a between-subjects effect of gender, $F\ (1, 24) = 1.38$, $p = .25$, $\eta^2 = .05$, results did indicate a significant time x gender interaction, Pillai's $V = .18$, $F\ (1, 24) = 5.28$, $p = .031$, $\eta^2 = .18$, as the perceived value of STEM increased from pretest to posttest for girls but decreased for boys (see Figure 1).

Table 1
Correlations, Means, and Standard Deviations for Study Variables

Variable	1	2	3	4	5
1. Investigative Type	--				
2. Situational Interest	0.31*	--			
3. SSACM	0.41*	0.52**	--		
4. Cyber Value T1	0.07	0.14	0.08	--	
5. Cyber Value T2	-0.20	0.35	0.07	0.75***	--
5. *M*	28.57	5.68	5.73	5.79	5.97
6. *SD*	10.71	0.99	1.04	1.71	1.40

Note. SSACM = Subjective Science Attitude Change Measures.
* $p < .05$ *** $p < .001$.

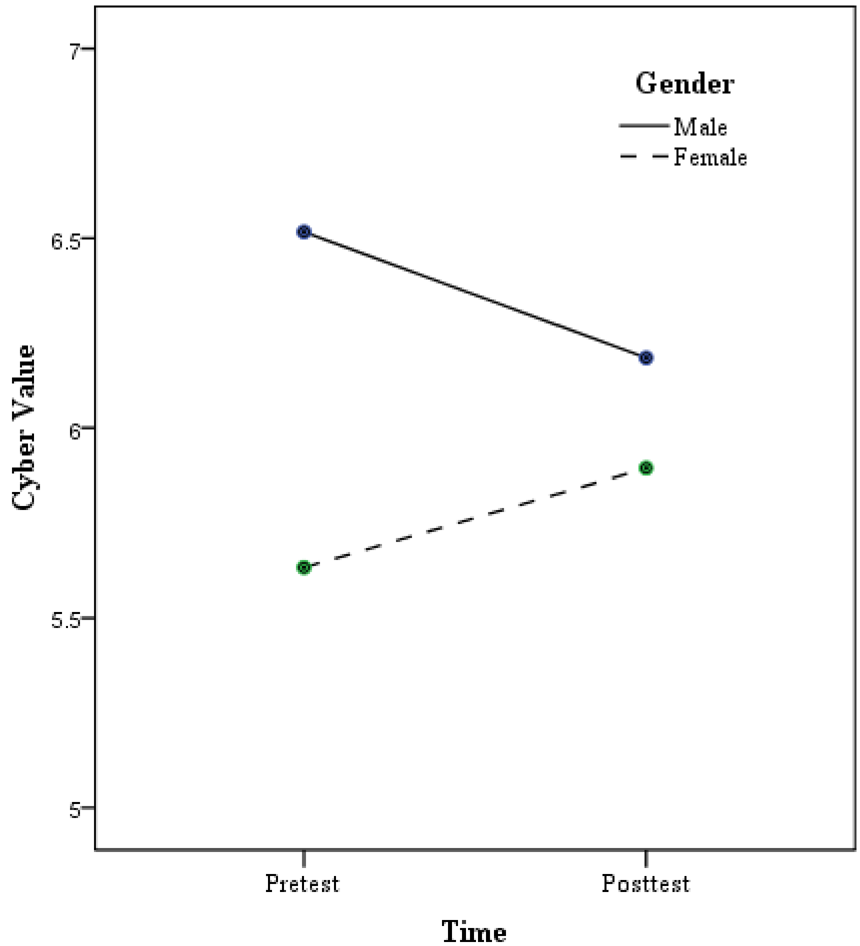

Figure 1. Plot of cyber value scores as a function of time

Next, we followed Baron and Kenny's (1986) causal steps approach to mediation analysis, which states that three conditions must be met for mediation to be inferred: (a) the exogenous predictor variable (X) must be significantly related to the outcome variable (Y); (b) X must be significantly related to the mediator variable (Z); and (c) Z must be a significant predictor of Y while controlling for the effects of X. Partial mediation is said to occur if magnitude of the relationship between X and Y is significantly reduced, whereas full mediation is said to occur if the X-Y relationship reduces to zero after entering Z into the regression equation. We utilized a hierarchical regression approach to test the mediation hypothesis given that this method lends itself well to examining the unique contribution of predictor variables while controlling for others. Holland Investigative type was entered into the regression equation on the first step of the analysis followed by situational interest on the second step. Results indicated that the step 1 model was significant, F (1, 23) = 4.16, p = .053, (β = .39), as Investigative type explained 15% of the variance in science-self efficacy. Situational interest accounted for an additional 20% of the variance in science self-efficacy on step 2, ΔF (1, 22) = 6.63, p = .017, (β = .49). The relationship between Holland Investigative type and science self-efficacy was shown to be nonsignificant on step 2, (β = .19, p = .33), thus supporting our hypothesis.

Discussion

Cyber science has become an increasingly important STEM discipline given the rapid pace of technological advancement. Considerable effort will be needed by education and industry stakeholders to keep pace with this demand for qualified personnel but with the historically low interest in cyber science among females, this will be a difficult task. The results of the present study suggest that, consistent with our hypothesis, girls' perceptions of cyber value can indeed be increased using an intervention designed to integrate skills needed for both STEM (e.g., mechanical reasoning) and liberal arts (e.g., communication skills) careers. In turn, learning to value a collection of tasks is likely to lead to the development of enduring interest (Assor, Kaplan, & Roth, 2002). One possible explanation for girls' increase in cyber science valuation is that the Cyber Discovery camp involved highly interactive group-based experiences that involved not only students, but their high school teachers as well. Given that girls tend to be more interpersonally-oriented than boys (Wong & Csikszentmihalyi, 1991) and derive significant benefit from hands-on, laboratory-type experiences (Lee & Burkam, 1996), the interpersonal and hands-on nature of the Cyber Discovery experience likely stimulated learning for the female campers, perhaps leading them to see greater utility in cyber science tasks. Moreover, having a teacher in each of the work groups may have been more beneficial for girls than boys since females who are exposed to positive same-sex role models tend to experience strong STEM career aspirations (Young, Rudman, Buettner, & McLean, 2013). Of course, teacher gender was not a focal variable in the present study, therefore this interpretation of the data would need to be substantiated in future research.

Although we predicted that boys' perceptions of cyber value would remain unchanged from pretest to posttest, boys actually reported a decrease in cyber value. This was an unusual and unexpected finding, but not unprecedented. Hulleman et al. (2010) found that a relevance intervention actually led to a slight decrease in perceived utility value among individuals with high performance expectations. The same pattern of effects may have been in operation in the present study. It is possible that the boys held overly high performance expectations for the camp and when they discovered how challenging some of tasks were, they may have devalued the importance of cyber science as a means of protecting their self-worth. Covington (1992) has suggested that many students are motivated to maintain a positive self-image, sometimes even at the expense of their own performance on achievement-related tasks. Thus, when self-worth protecting students fear that failure on a task is likely they may engage in self-handicapping behaviors such as effort withdrawal and lower pre-task commitment. In the event that self-worth protective students exert sufficient effort on a task but perceive themselves to have underperformed after the fact, they are likely to deflect attention to their ability and instead avoid personal responsibility by making external attributions for their performance (Thompson, Davidson, & Barber, 1995). To test this proposition, future research on the effectiveness of the Cyber Discovery program should include pretest measures of performance expectations and posttest measures of performance appraisals.

Because interest development is so critical to academic performance and occupational choice, we also hypothesized that situational interest would mediate the relationship between vocational interest type and cyber science self-efficacy. This hypothesis was supported as results showed that the relationship between vocational interest and cyber science self-efficacy became nonsignificant when situational interest was entered into the regression equation. This finding makes intuitive sense as Holland interest types have been shown to be quite stable as predictors of career outcomes. A stable trait-like construct such as Investigative interest type should, theoretically, predispose scientifically-minded students to the experience of enjoyment, provided the task offers sufficient appeal to facilitate task interest. Educators who develop STEM interventions can never be quite sure how students will respond to the tasks they are presented with, thus it is important that a proper person-environment fit be sought such that students with certain intellectual predispositions are matched with tasks that are likely to spark their interest and motivation. The Cyber Discovery program was successful in this respect as our findings suggest that the tasks developed for the program are capable of engendering interest in novel cyber-related tasks. Moreover, situational interest was predictive of increased confidence for cyber science. This bodes well for future cyber involvement as social cognitive theory (Bandura, 1997) posits that individuals who feel more efficacious in a given domain are more likely to perform well, and thus seek out similar tasks in the future. Longitudinal research is needed to better understand whether or how cyber-related interests and self-efficacy beliefs are maintained over time.

The present findings are believed to have important implications for science educators. The unique aspect of the Cyber Discovery program is that it involves high school teachers assuming the role of learner alongside their students. This allows student participants to relate to their teachers as both peers and students while interacting with camp content material. A learning environment such as this may be a central factor in determining the degree to which students begin to value and develop self-efficacy for cyber science. Diffusing student perceptions of their teachers as 'grader' versus mentor and guide has been apparent through student interviews and focus groups and this aspect of the program could also be the basis of future research.

Towards a national model

Cyber Discovery is now expanding through the recent creation of the U.S. Department of Homeland Security Cybersecurity Education and Training Assistance Program (CETAP) initiative, a major part of which is the replication of the Cyber Discovery model highlighted in this paper. As stated in their executive summary of the program, "DHS has an interest in promoting cybersecurity education in state and local government agencies and educational institutions, as well as providing a mechanism whereby cybersecurity education is available not only in the form of the formal education of students, but in the professional development of their teachers. Programs such as these are key to developing students' interest in the cybersecurity career field at an early stage to bolster the pipeline of future cybersecurity professionals" (U.S. Office of Management and Budget, 2011). To this end, Cyber Discovery has become a premier program that reaches both students and their teachers by challenging them across multiple disciplines in an interdisciplinary way; thus showcasing the needs of our society for better cyber-citizens who help cybersecurity efforts and strengthen the future directions of our national security.

In 2012 and 2013, Cyber Discovery was replicated at the University of Baltimore and will continue in 2014. Through funding provided in the CETAP initiative, two new universities will replicate the program in the 2013-14 academic year, with two additional universities joining the program replication effort in 2014-15. Thus, in 2014, we anticipate having more than 60 university faculty from six different universities around the United Stated engaged in the overall professional development program. Assuming continued support through DHS, the program is on a growth trajectory to reach over 65 universities in the next decade, thereby engaging over 400 university faculty working with over 10,000 high school teachers reaching over 2 million high school students. With the potential for future research efforts across the expanding Cyber Discovery footprint, we are on the verge of establishing a national test-bed for research efforts similar to the one highlighted here.

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