Army Educational Outreach Program

College Qualified Leaders

2013 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

February 14, 2014

U.S. Army Contacts

Jeffrey Singleton
Director, Basic Research and Educational Outreach
Office of the Assistant Secretary of the Army
Acquisition, Logistics, & Technology
(703) 617-0315
Jeffrey.d.singleton.civ@mail.mil

Andrea Simmons-Worthen
Army Educational Outreach Program Director on
behalf of the Office of the Deputy
Secretary of the Army for Research & Technology
(703) 617-0202
andrea.e.simmons.ctr@mail.mil

AEOP Cooperative Agreement Managers

Louie Lopez
AEOP Cooperative Agreement Manager
U.S. Army Research, Development, and
Engineering Command (RDECOM)
(410) 278-9858
louie.r.lopez.civ@mail.mil

Jennifer Carroll
AEOP Deputy Cooperative Agreement Manager
U.S. Army Research, Development, and
Engineering Command (RDECOM)
(410) 306-0009
jennifer.j.carroll2.civ@mail.mil

College Qualified Leaders Program Administrators

Artis Hicks
CQL Program Manager
American Society for Engineering Education
(202) 331-3558
a.hicks@asee.org

Tim Turner
Principal Investigator
American Society for Engineering Education
(202) 331-3514
t.turner@asee.org

Report CQL_02_02142014 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by Virginia Tech under award W911NF-10-2-0076.

Virginia Tech Evaluation Contacts

Rebecca Kruse, Ph.D.
Evaluation Director, AEOP CA
Virginia Tech
(703) 336-7922
rkruse75@vt.edu

Donna Augustine Burnette
Program Director, AEOP CA
Virginia Tech
(540) 315-5807
donna.augustine@vt.edu

Virginia Tech Principal Investigators

Susan Short, Ph.D.
Associate Vice President for Engagement
Virginia Tech
(540) 231-9497
sshort@vt.edu

Scott Weimer
Director of Continuing and Professional Education
Virginia Tech
(540) 231-7887
weimers@vt.edu

Contents

Executive Summary

The College Qualified Leaders (CQL) program, managed by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) that matches talented college students and recent graduates (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentice training that is unparalleled at most colleges. CQL allows alumni from Gains in the Education of Mathematics and Science (GEMS) and Science and Research Apprentice Program (SEAP) to continue their relationship with the mentor and/or laboratory, and also allows new college students to enter the program as well. CQL apprentices offers the provision of summer, partial year, or year-round research at the Army laboratory, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army research laboratories. CQL fosters desire in its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

In 2013, CQL provided outreach to 260 apprentices and their mentors at 10 Army laboratory sites (herein called CQL sites). This is a decline of 5% from the 274 apprentices in 2012. In 2013, 588 students submitted applications to the program, up 58% from 373 student applicants in 2012.

This report documents the evaluation of the 2013 CQL program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for CQL included: in-person focus groups with apprentices and mentors at 4 CQL sites and online post-program questionnaires distributed to all apprentices and mentors.

Table 1. 2013 CQL Fast Facts	
Major Participant Group	College Students
Participating Students	260
Participating Army S&Es	260
Participating Army Agencies	10
Total Cost	$2,407,923
Total Stipends	$2,341,279
Cost Per Student Participant	$9,261

Summary of Findings

The 2013 evaluation of CQL collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 2.

Table 2. 2013 CQL Evaluation Findings	
Participant Profiles	
All evaluation data contribute to the overall narrative of CQL's efforts and impact, and highlight areas for future exploration in programming and evaluation. However, confidence in evaluation findings varies by participant group.	• Statistical reliability calculated for the apprentice questionnaire (margin of error = ±8.1% at 95% confidence level) and alternative methods for establishing representativeness (statistical comparison of apprentice respondents' and participants' demographic information revealed no significant differences) suggest findings from the apprentice questionnaire may be sufficiently generalizable to the apprentice population.
	• Statistical reliability calculated for the mentor questionnaire (margin of error = ±20% at 95% confidence level) and lack of available demographic information with which to make alternative determinations suggest mentor respondents may not be representative of the mentor population. Mentors contribute valuable perspective to CQL evaluation and any findings from mentor questionnaires should be cautiously generalized with consideration given to the margin of error and with triangulation of findings with other data.
CQL had some success in providing outreach to participants from historically underrepresented and underserved populations.	• Apprentices included female students (35%)—a population that is historically underrepresented in some STEM fields.
	• Apprentices identified as Black or African American (9%) and Hispanic or Latino (5%), and American Indian or Alaskan Native (1%)—these populations are among those historically considered underserved and underrepresented in STEM education.
	• Mentors identified as predominantly male (67%) and White or Caucasian (57%). Of the 22 mentor respondents, 15% identified as Black or African American (10%) and Hispanic or Latino (5%).
CQL serves the Nation's future STEM workforce.	• Most CQL apprentices are pursuing STEM degrees. 95% of apprentices planned to pursue a degree in a STEM field (10% Bachelors, 33% Master's, 52% Doctorate.)
	• Most CQL apprentices intend to pursue STEM careers. Most frequently, apprentices reported currently working on engineering degree (48%) and similar intent to pursue an engineering career (48%). Medicine/health was the second most frequent career field listed (17%). Apprentices also intended to pursue careers in life science (9%), chemistry (7%), physical science (6%) and math/computer science (3%), as well as other STEM (6%) and non-STEM (2%) fields.
Actionable Program Evaluation	
CQL marketing and recruitment was largely a site-based endeavor.	• CQL sites marketed CQL to local universities and educators, as well as to participants of other AEOP programs at the site.
	• More than one third of apprentice interviewees reported learning about CQL through friends, family, family friends, or university professors with connections to CQL site, program, or mentor. Similarly, 37% of apprentice questionnaire respondents reported having a family member or family friend at the Army research facility where the CQL apprenticeship took place.
	• More than one third of apprentice interviewees learned of CQL through GEMS, SEAP, or Near Peers programs at the site. Questionnaire respondents reported past participation in GEMS (10%), SEAP (24%), and Near Peers (3%).
	• Many mentors reported selecting apprentices that had been "vetted" by a personal or professional connection of the mentor.
CQL apprentices desired repeated engagement at	• Apprentices were motivated to participate in CQL by their desire for repeated engagement at the Army labs after participating in CQL or other AEOPs at the site (e.g., GEMS, SEAP, or

Army labs and opportunities to advance their STEM pathways.	Near Peers) Apprentices also participate because they generally wish to advance their STEM pathways: build research skills, gain research experience, apply school learning, and their build applications or resumes.
CQL mentors sought opportunities to engage with STEM learners in their work.	• Mentors chose to participate in CQL because of positive experiences as CQL, SEAP, or GEMS mentors, for opportunities to re-engage former apprentices in the research project, and to have project needs met by hosting an apprentice.
CQL mentors used a team-based approach to engaging their apprentices in STEM research and supporting their educational and career pathways.	• Apprentices and mentors questionnaire respondents reported similar frequencies of mentor activities related to engaging apprentices in STEM research. Similarly, apprentice and mentor interviewees frequently reported activities reviewing apprentice work and giving feedback; grounding laboratory work in scientific principles and practices; and training the apprentice to perform laboratory tasks and procedures.
	• Moderately large to very large significant differences were found in apprentices' and mentors' perceptions support for educational and career pathways. Other laboratory personnel contributing to the day-to-day mentoring of apprentices may provide other mechanisms for support of educational and career pathways beyond that provided by Army S&Es.
CQL mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers.	• Most mentor interviewees had limited awareness of AEOP initiatives. Subsequently, mentors did not consistently educate their apprentices about AEOPs or encourage apprentices to participate in them.
	• Mentors suggested that informational resources provided to mentors or apprentices, mentor training, and clear expectations for promoting other AEOPS were necessary to accomplish this objective.
	• Mentors reported a variety of strategies for mentoring apprentices about STEM careers, with a strong emphasis on Army/DoD STEM careers. Some mentors suggested that the experience itself educated apprentices about STEM research and careers with the Army.
	• Mentors perceived that furloughs, their own lack of awareness, and lack of resources for educating about STEM careers were challenges to providing career mentorship. Mentors requested resources to share with apprentices and suggested a number of programmatic changes that would increase the visibility of Army/DoD STEM professionals in CQL.
CQL benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that CQL benefits apprentices by providing authentic research opportunities not typically available in school settings, opportunities to expand their STEM competencies and confidence in those competencies, and opportunities to advance their STEM pathway, and access to effective mentorship.
	• Mentors also perceived benefits to their laboratories and to themselves. Most notably, mentors indicated that apprentices are low-cost yet highly effective members of the lab, and apprentices have made meaningful contributions to research with near-term impact on Army processes or procedures.
CQL's administrative processes and mentee-mentor matching are	• Apprentices and mentors perceived challenges with the "cumbersome" and "time-consuming" administrative tasks associated with the CQL, suggesting they detract from work that can be accomplished during an already short (and furlough-disrupted) summer apprenticeship. Mentors perceived low organization of and support for these tasks.

possible areas for improvement.	• Apprentices suggested processes for mentee-mentor matching could be improved to ensure apprentices have sufficient work to do and can contribute beyond a singular task or procedure. One apprentice suggested professional development is needed for mentors.
Outcomes Evaluation	
CQL engaged apprentices in authentic STEM activities more frequently than their school environment.	• Apprentices reported that CQL provided more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (35%-69% in CQL, 16%-46% in school) and hands-on research activities (29%-71% in CQL, 16%-39% at school). Small to moderately large, significant differences were found for 9 of 12 STEM activities.
	• Apprentice and mentor data suggested CQL had a slightly larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
CQL apprentices became more confident in STEM, and mentors rated their research and reporting skills highly.	• A majority of apprentices (68%-85%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (53%-91%) rated their apprentices at near expert or expert levels of the development continuum across 6 key STEM skills and abilities: information literacy, scientific reasoning, laboratory, data collection, quantitative literacy, and teamwork and collaboration. Most mentors (92-100%) also rated all 6 components of their apprentices' final research project or presentation as near expert or expert level.
CQL apprentices intended to pursue more STEM activities, including serving as STEM role models.	• 73-87% of CQL apprentices intend to pursue STEM activities after participating in CQL, including studying more STEM, learning more about topics they learned about in CQL, and joining professional organizations.
	• 57-84% of CQL apprentices intend to serve as a role models by sharing their CQL experiences with friends, recommending CQL to friends, encouraging friends to study more STEM, and mentoring younger STEM learners.
CQL apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Many apprentices (29-99%) and mentors (43-84%) were unaware of other AEOP initiatives, with higher proportions lacking awareness for programs occurring outside of the CQL site.
	• CQL apprentices are interested in participating in other AEOP opportunities: college apprenticeships (25%), college scholarship programs (22%), and graduate fellowships (8%) offered by AEOP or DoD. This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
	• A small proportion of CQL apprentices (1%-4%) expressed interest in middle and high school programs, presumably as mentors or other volunteers.
CQL improves and sustains apprentices' positive attitudes toward the defense community and their interest in potential government service.	• Many apprentices had opportunities to learn about new STEM careers during CQL as reported by apprentices and mentors (50% apprentices, 24% mentors). Army/DoD STEM careers received substantial attention (75% apprentices, 30% mentors). Apprentices clearly have other opportunities to and mechanisms for learning about new STEM and Army/DoD STEM careers beside direct contact with the mentor.
	• CQL served to inspire interest in new STEM careers, with 43% of apprentices expressing new interest in Army/DoD STEM careers in particular. Since 83% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society, suggesting that CQL also sustains existing interest in Army/DoD careers.

	• Most apprentices (85%) credited CQL with improving their understanding Army/DoD STEM contributions. Most mentors (62%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Coordinated efforts should be made by the Army, ASEE managers, and site coordinators to encourage and improve apprentice and mentor participation in the CQL evaluation efforts. The low response rates to evaluation assessments pose the most significant threat to the validity of findings from those assessments, and, furthermore, prevent any reliable comparisons from those data from year to year. While evaluators can assess representativeness of samples through alternative means, accurate demographic data must be available for the population in order to accomplish these determinations. With respect to the outcomes evaluation, mentors' assessment of apprentice performance are important for triangulating apprentices' perceptions of growing confidence in their STEM competencies. Future evaluation will continue to rely on mentors to provide an authoritative, albeit subjective, assessment of apprentices' performance and *growth* in apprentices' STEM competencies. Mentors reported awareness of and efforts to promote AEOP and Army STEM are important for understanding related apprentice outcomes and identifying site-level programming needs (e.g., resources and/or training for mentors). Evaluators will endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments; however, evaluators necessarily rely on the assistance of Army, ASEE managers, and site coordinators to promote a culture of evaluation among both CQL apprentices and mentors.

2. The number of applications for CQL apprenticeships (588 applications for 260 funded apprenticeships) is indicative of unmet need. Of particular note, rate of participation varied from 0% to 53% at CQL sites having greater than 19 applicants. To the extent allowed by annual budget constraints, CQL should endeavor to engage more Army S&E mentors, thereby creating more apprenticeship positions to populate. CQL programming may benefit from a careful examination of and attention to program- and site-level structures, processes, and resources that both enable and discourage Army S&Es' participation in CQL. Program- and site-level accommodations may be required to further improve Army S&Es' awareness of CQL, feasibility of their participation, and overall motivation to participate in CQL. Mentors noted multiple challenges that they or their apprentices encountered that, if eliminated could provide greater retention of existing mentors and increased recruitment of new mentors. Simultaneous with this effort, ASEE and CQL sites might consider how to effectively recruit a more demographically diverse mentor pool to provide apprentices with greater access to same-demographic role models and mentors.

3. CQL and AEOP objectives include the inclusion and expansion of students from historically underrepresented and underserved populations in programs. While ASEE and local sites conduct targeted marketing of CQL to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in determining CQL apprentices. CQL may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide,

including but not limited to 1) maximizing the recruitment and repeated engagement of female, racial/ethnic minorities, and low income students in GEMS and SEAP programming (where available), 2) subsequent recruitment of those alumni as CQL apprentices, and 3) recruiting new students into the pipeline from historically black colleges and universities and other minority serving institutions. Guidance may also be provided to ensure other "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and CQL sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site).

4. ASEE, CQL sites, and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encourage continued participation in programs for which apprentices qualify. Evaluation data suggests that CQL apprentices and mentors were largely unaware of other AEOP initiatives, especially those offered outside of the Army research facilities. Yet, apprentices showed interest in university-based apprenticeships and undergraduate scholarships, as well as in AEOPs offered to younger STEM learners (presumably interested in serving as mentors). This interest would benefit from more robust attention by site coordinators and mentors during CQL program activities. Continued guidance by ASEE is needed for educating CQL site coordinators and mentors about AEOP opportunities, especially beyond the CQL sites. Adequate resources and guidance for using them with apprentices should be provided to all site coordinators and mentors in order that all apprentices leave CQL with an idea of their next steps in AEOP, whether at or outside of the Army site.

5. Most apprentices had opportunities to learn about STEM research and careers during CQL, especially Army/DoD STEM research and careers to which they are exposed daily. However, many mentors reported lack of awareness of STEM careers beyond their own, lack of informational resources, and lack of time for not educating apprentices about other STEM careers. Evaluation findings also suggest that other laboratory personnel contribute substantially to the mentorship of apprentices, and may be providing more support for educational and career pathways than the mentor. Thus, they would benefit from the same supports requested by mentors. We strongly recommend a CQL- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[1]

[1] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

Introduction

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K-college programs and expose them to Department of Defense (DoD) STEM careers. The consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), supports the AEOP in this mission by engaging non-profit, industry, and academic partners with aligned interests, as well as a management structure that collectively markets the portfolio among members, leverages available resources, and provides expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM goals and objectives.

This report documents the evaluation of one of the AEOP elements, the College Qualified Leaders (CQL) program. CQL is managed by the American Society for Engineering Education (ASEE). The evaluation was performed by Virginia Tech, the Lead Organization (LO) in the AEOP CA consortium.

AEOP Goals

Goal 1: STEM Literate Citizenry.

- Broaden, deepen, and diversity the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators.

- Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure.

- Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

Program Overview

The College Qualified Leaders (CQL) program, managed by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) that matches talented college students and recent graduates (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentice training that is unparalleled at most colleges. CQL allows alumni of Gains in the Education of Mathematics and Science (GEMS) and/or Science and Engineering Apprentice Program (SEAP) to continue their relationship with the mentor and/or laboratory, and also allows new college students to enter the program as well. CQL apprentices offers the provision of summer, partial year, or year-round research at the Army laboratory, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army research laboratories. CQL fosters desire in its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

In 2013, CQL was guided by the following objectives:

1. To nurture interest and provide STEM research experience for college students and recent graduates contemplating further studies;
2. To provide opportunities for continued association with the DoD laboratories and STEM enrichment of previous SEAP, GEMS, and other AEOP participants as well as allow new college students the opportunity to engage with DoD laboratories;
3. To outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM;
4. To increase participant knowledge in targeted STEM areas and develop their research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research;
5. To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories;
6. To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community; and
7. To provide information to participants about opportunities for STEM enrichment and ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.

Apprenticeships were completed at 8 Army research laboratories in 4 states, summarized in Table 3. Apprenticeships were also granted at the Naval Medical Research Center.

Table 3. 2013 CQL Sites

Laboratory	Command*	Location
Defense Forensic Science Center (DFSC)[2]		Forest Park, GA
US Army Center for Environmental Health Research (USACEHR)	MRMC	Fort Detrick, MD
US Army Medical Research Institute of Chemical Defense (USAMRICD)	MRMC	Aberdeen, MD
US Army Medical Research Institute for Infectious Diseases (USAMRIID)	MRMC	Fort Detrick, MD
Walter Reed Army Institute of Research (WRAIR)	MRMC	Silver Spring, MD
US Army Aviation & Missile Research Development and Engineering Center-Redstone Arsenal (AMRDEC)	RDECOM	Huntsville, AL
US Army Research Laboratory- Aberdeen Proving Ground (ARL-APG)	RDECOM	Aberdeen, MD
US Army Research Laboratory – Adelphi (ARL-A)	RDECOM	Adelphi, MD
Engineer Research & Development Center-Construction Engineering Research Laboratory (ERDC-CERL)	USACE	Champaign, IL
Engineer Research & Development Center- Vicksburg, MS (ERDC-MS)	USACE	Vicksburg, MS

Commands: "MRMC" is the Medical Research and Materiel Command, "RDECOM" is the Research Development and Engineering Command, and "USACE" is the US Army Corps of Engineers.

[2] CQL apprentices working at DFSC identified as working with the U.S. Army Criminal Investigation Laboratory (Fort Gillem, GA) within the Criminal Investigation Command.

In 2013, CQL provided outreach to 260 apprentices and their mentors at 10 Army laboratory sites (herein called CQL sites). This is a decline of 5% from the 274 apprentices in 2012. In 2013, 588 students submitted applications to the program, up 58% from 373 student applicants in 2012.

Table 4 provides the application (App) and participation (Part) data by CQL site for 2011-2013.

Table 4. 2011-2013[3] CQL Participation by Command

Command	Lab	2011			2012			2013		
		# App	# Part	Rate	# App	# Part	Rate	# App	# Part	Rate
CID	DFSC[4]							11	11	100%
	USACIL			%			%	21	0	0%
MRMC	USAARL			%			%	0	0	0%
	ARL-CSID			%			%	0	0	0%
	USAFMES			%			%	0	0	0%
	USACEHR			%			%	19	8	42%
	USAMRICD			%			%	22	9	41%
	USAMRIID			%			%	32	14	44%
	USARIEM			%			%	0	0	0%
	USAISR			%			%	0	0	0%
	WRAIR			%			%	184	97	53%
RDECOM	ECBC			%			%	0	0	0%
	NVESD			%			%	0	0	0%
	AMRDEC			%			%	32	2	6%
	ARL-APG			%			%	133	59	44%
	ARL-A			%			%	93	48	52%
	NSRDEC			%			%	0	0	0%
	ARL-WSMR			%			%	0	0	0%
USACE	ERCD-CERL			%			%	24	8	33%
	ERCD-MS			%			%	4	4	100%
	NSC-WP			%			%	0	0	0%
	ERDC-GSL			%			%	0	0	0%
	ERDC-TEC			%			%	0	0	0%
Total				%	**373**	**274**	**73%**	**588**	**260**	**44%**

[3] 2011 and 2012 are unavailable at the time of this report. This data collection effort is underway, directed by Army Cooperative Agreement Managers. These data will be included in an amended report that is submitted to the Army, when they become available.

[4] CQL apprentices working at DFSC identified as working with the U.S. Army Criminal Investigation Laboratory (Fort Gillem, GA) within the Criminal Investigation Command.

The total cost of 2013 CQL was approximately $2,407,923. This cost includes administrative costs of $66,644 (calculated as half of ASEE's expenditures for the administration of SEAP and CQL) and $2,341,279 for participant stipends. The average cost per 2013 CQL participant taken across all CQL sites was $9,261. Table 5 summarizes these expenditures.

Table 5. 2013 CQL Costs	
2013 CQL - Cost Per Participant	
Total Participants	260
Total Cost	$2,407,923
Cost Per Participant	**$9,261**
2013 CQL - Cost Breakdown	
Administrative Cost	$66,644
Participant Stipends	$2,341,279
Total Program Cost	**$2,407,923**

Evidence Based Program Change

ASEE's efforts primarily focused on tasks associated with transitioning the management of the CQL program from George Washington University to ASEE, including:

1. collaborating with CQL site coordinators for program promotion, applicant selection, applicant security/access approval, payment of stipends, and administration of evaluation assessments;
2. establishing print and electronic promotional materials for distribution to organizations and individuals; and
3. updates to the CQL website.

The 2013 evaluation was the first ever evaluation of CQL (previously, SEAP and CQL programs had been merged). The evaluation focused on evaluating outcomes aligned with AEOP and program objectives, and included AEOP-wide assessment priorities, including:

1. Focus groups conducted with apprentices and mentors at 4 CQL sites;
2. Enhanced Actionable Program Evaluation, including participants' perceptions of:
    - Marketing and recruitment to the CQL program;
    - Motivation to participate in CQL;
    - Satisfaction with CQL activities;
    - Benefits of CQL; and
    - Suggestions for improvement to CQL.
3. Baseline data collection from mentors on current activities, challenges, and additional support needed related to
    - Educating apprentices about AEOP opportunities; and
    - Educating apprentices about AEOP opportunities STEM jobs, and specifically Army/DoD STEM jobs.

2013 Evaluation At-A-Glance

Virginia Tech, in collaboration with ASEE, conducted a comprehensive evaluation study of the CQL program. The CQL logic model below presents a summary of the expected outputs and outcomes for the CQL program in relation to the AEOP and CQL-specific priorities. This logic model provided guidance for the overall CQL evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • ASEE providing oversight of site programming • Operations conducted by 10 Army labs • 260 Students participating in CQL apprenticeships • 260 Army S&Es serving as CQL mentors • Stipends for students to support meals and travel • Centralized branding and comprehensive marketing • Centralized evaluation	• Students engage in authentic STEM research experiences through hands-on summer, partial year, and year-round apprenticeships at Army labs • Army S&Es supervise and mentor students' research	• Number and diversity of student participants engaged in CQL • Number and diversity of Army S&Es engaged in CQL • Students, Army S&Es, site coordinators, and ASEE contributing to evaluation	• Increased student STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased student interest in future STEM engagement • Increased student awareness of and interest in other AEOP opportunities • Increased student awareness of and interest in STEM research and careers • Increased student awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve CQL programs	• Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of CQL

The CQL evaluation gathered information from apprentice and mentor participants about CQL processes, resources, activities and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and CQL program objectives

Key Evaluation Questions

- What aspects of CQL motivate participation?
- What aspects of CQL structure and processes are working well?
- What aspects of CQL could be improved?
- Did participation in CQL:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for CQL included onsite focus groups with apprentices and mentors at 4 CQL sites, a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubrics.

Tables 6 and 7 outline the information collected in apprentice and mentor assessments that are relevant to this evaluation report.

Table 6. 2013 Apprentice Assessments	
Category	**Description**
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education and Career Intentions: Intended degree, field, and confidence to achieve education goals; Confidence to achieve career goals
Satisfaction & Suggestions	Awareness of CQL, motivating factors for participation, satisfaction with and suggestions for improving CQL programs
AEOP Goal 1 Indicators of Program Achievement	**STEM Competencies:** Perceptions of opportunities to engage in STEM activities in CQL (as compared to in college courses and labs), self-reported change in confidence in their STEM competencies
	STEM Engagement: Interest in future STEM engagement, including as STEM role models
	Army STEM: AEOP Opportunities –Past participation, exposure to, and interest in participating in other AEOP programs
	Army STEM: Army/DoD STEM Careers –Exposure to STEM and Army/DoD STEM jobs, change in interest for STEM and Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers
AEOP Goal 2 Program Efforts	**Mentor Capacity: Army S&Es—**Apprentices' perceptions of day-to-day mentor activities

Table 7. 2013 Mentor Assessments	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of CQL, motivating factors for participation, satisfaction with and suggestions for improving CQL programs, benefits to participants
AEOP Goal 1 Indicators of Program Achievement	**STEM Competencies:** Mentors' assessment of apprentices' STEM competencies after CQL and final presentation/project
AEOP Goal 1 & 2 Program Efforts	**Army STEM: AEOP Opportunities –** Mentor awareness and efforts to expose apprentices to AEOP opportunities, perceptions of apprentice interest in AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Mentor efforts to expose apprentices to STEM and Army/DoD STEM careers, perceptions of apprentice interest in STEM and Army/DoD STEM research and careers
	Mentor Capacity: Army S&Es—Mentors' perceptions of day-to-day mentor activities

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data is summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the

report narrative, with tables and/or footnotes providing results from tests for significance.[5] Questionnaires and respective data summaries are provided in Appendix B (apprentice) and Appendix C (mentor). Focus group protocols are provided in Appendices D (apprentices) and E (mentors). Major trends in data and analyses are reported herein.

Study Sample

The post-CQL questionnaires were provided to the 2013 CQL sites in electronic format using the Qualtrics® survey system hosted by Virginia Tech. A total of 94 apprentices from 7 CQL sites responded to the apprentice questionnaire. In addition, 22 mentors from 6 CQL sites responded to the mentor questionnaire and rubrics.

Table 8 provides an analysis of apprentice and mentor participation in post-CQL questionnaires, including the response rates and statistical reliability achieved with each sample, as given by the margin of error at the 95% confidence level. The margin of errors calculated for apprentices (±8.1%) and mentors (±19.6%) exceed an acceptable levels and suggest limited representativeness of the respondent samples to the respective participant populations. However, a comparison of apprentice questionnaire respondents with apprentice participant demographics (obtained from ASEE's registration data) shows no statistically significant differences key demographic characteristics of gender and race or ethnicity. In addition, apprentice questionnaire respondents represent 70% of the 10 CQL sites. Statistical reliabilities and alternate methods for establishing representativeness suggest findings from the apprentice questionnaire respondents may be sufficiently generalizable to the apprentice population. Similar demographic information is not available for the mentor participant population with which to make alternative determination of representativeness. Mentors contribute valuable perspective to CQL evaluation but should be cautiously generalized, with consideration given to the margin of error and to triangulation of findings with other data. Participation of apprentices and mentors are critical for establishing reliable evaluation and is a critical area for attention in future CQL programming.

Table 8. 2013 CQL Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[6]
Apprentices	94	260	55%	±8.1%
Mentors	22	260	13%	±20.3%

Focus groups were conducted at 4 CQL sites in the Eastern, U.S. Mentor focus groups included 20 Army S&E mentors for SEAP and/or CQL (10 females, 10 males). SEAP and CQL mentors were interviewed together (as they often worked with both programs), but herein they will be referred to as CQL mentors. Apprentice focus groups included 33 apprentices (19

[5] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

[6] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, 95% of the time, between 42% (47-5) and 52% (47+5) would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

females, 15 males). Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of questionnaire data.

All data collected contribute to the overall narrative of CQL's efforts and potential benefit to participants, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Apprentice demographics. Demographic information collected from 2012 and 2013 CQL apprentice questionnaire respondents are summarized in Table 9.

Table 9. 2013 CQL Apprentice Questionnaire Respondent Demographics

Demographic Category	No.	%
Gender		
Female	33	35%
Male	30	64%
Choose not to report	1	1%
Race/Ethnicity		
American Indian or Alaskan Native	1	1%
Asian or Other Pacific Islander[7]	20	21%
Black or African American	8	9%
Hispanic or Latino	5	5%
White or Caucasian	55	59%
Other	0	0%
Choose not to report	5	5%
Age		
Average Age	21.1 years	
Age Range	18-27 years	
Degree Currently Pursuing		
Bachelor's	62	66%
Master's	15	16%
Doctorate (Ph.D.)	7	7%
Medical (M.D., D.O)	0	0%
Post Baccalaureate or Post Graduate	7	7%
Other	3	3%

Note: Other = Au.D. (n = 2) and "Just obtained BS in chemistry"

In 2013 more males (64%) than females (35%) completed the questionnaire. More respondents identified with race/ethnicity category of White or Caucasian (59%) than any other single race/ethnic category. Respondents included apprentices identifying as Black or African (9%), Hispanic or Latino (5%), and American Indian or Alaskan Native (1%). The

[7] The 2012 demographic category consisted of Asian-Pacific American, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

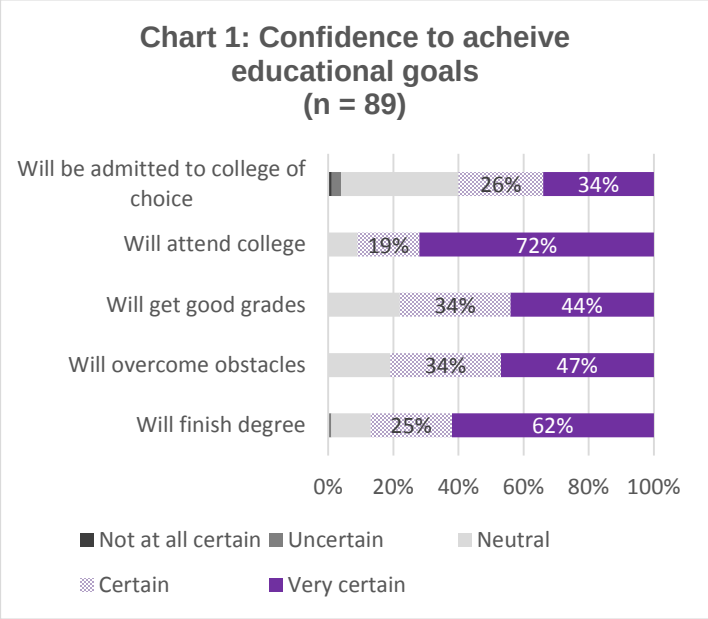
average age of apprentices was 21.1 years old. Data obtained from ASEE indicate a Gaussian-like distribution in apprentice grade levels finished before 2013 participation in CQL, from high school grade 12 to 4th year of college, with the highest proportions of apprentices in their 2nd year of college. This is consistent with evaluation data that indicates the majority of apprentices are currently pursuing a Bachelor's degree.

One objective of CQL (and all AEOPs) is to involve a larger percentage of students from previously underrepresented and underserved segments of our population, such as women, American Indians, African Americans, and Hispanics, in pursuing science and engineering careers through participation in Army-sponsored programs. Both 2013 evaluation data and registration data (obtained from ASEE) reveals CQL had limited success in engaging female students—a population that is historically underrepresented in certain STEM field—than male students. The same data suggest CQL had limited success in providing outreach to students from historically underserved minority race/ethnicity groups (15% of evaluation respondents, 13% of total participants). This remains an area for growth, one that is partially dependent upon other AEOPs for appropriately preparing students (e.g., in GEMS and/or SEAP) and encouraging them to pursue these more competitive apprenticeships.

Apprentice education and career intentions. The apprentice questionnaire included items to elicit apprentices' education goals (highest degree sought, field of study), their confidence to achieve these goals, and career aspirations (STEM, Army/DoD STEM, field of career). When reporting their confidence to achieve their educational goals, apprentices responded on a 6-point scale of 1 = "Not at All Certain" to 6 = "Very Certain." Charts 1 -3 summarize these data.

All (100% of 89) CQL apprentices who responded to the item intend to pursue a college degree, with most apprentices (95%) planning to pursue a degree in a STEM field. Most apprentices intended to pursue an advanced degree (33% Master's, 52% Doctorate.) Of the 5% intending to pursue non-STEM degrees, all 5% intended to pursue advanced degrees outside of STEM.

More than 60% of apprentices claimed to be certain or very certain they will achieve educational goals, as summarized in Chart 1. Apprentices were most certain (87%) that they will attain their ultimate education goal—a degree. Students were least certain (60%) they will be admitted to the college and their program of choice.



As illustrated by Chart 2, most CQL apprentices intend to pursue jobs (87%) or build STEM careers (83%). Significantly fewer apprentices intend to pursue jobs and careers with the Army/DoD. Significance testing suggests this difference between intent to pursue STEM jobs and careers and to pursue them with the Army/DoD is very large[8].

Chart 3 provides a visual comparison of apprentices' current field of study and their intended career field. Apprentices most frequently reported intent to engage in engineering (48%) and medical/health (17%) careers. There were no statistically significant differences in apprentices' current field of study and their intended future career fields.

Chart 2: STEM Career Intentions (n = 88)

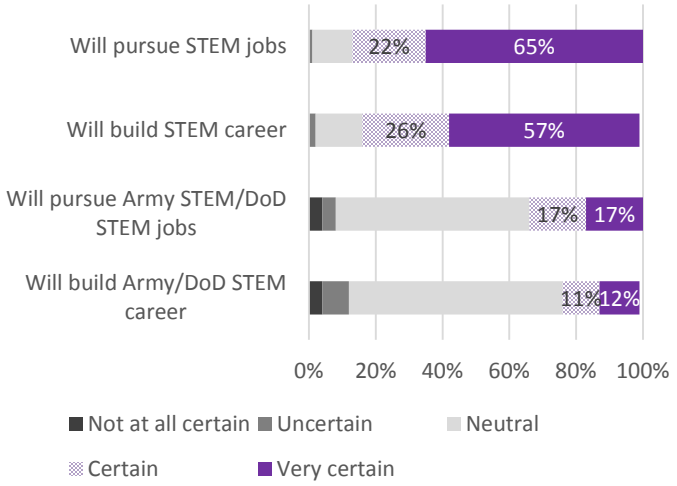
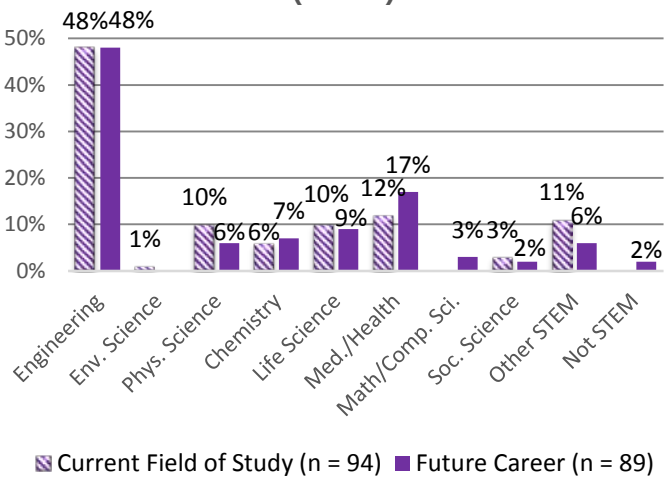


Chart 3. Current Field of Study and Future Career Fields Intentions (n = 89)



These particular items pertaining to apprentices' educational and career intentions do not discern whether CQL apprentices' education and career goals are established prior to participation, or to what extent their CQL participation in any way affects their pre-CQL goals. However, from these figures and other findings within this report, we can surmise that most CQL apprentices have well-established education and career goals for their STEM pathway and seek out CQL to advance in their STEM pathway. CQL clearly provides outreach to the Nation's future STEM workforce and, as demonstrated in the Outcomes Evaluation section, positively impacts many apprentices' awareness of, attitudes toward, and interest in Army/DoD STEM research and careers.

Past AEOP experiences. Apprentices were also asked about past experiences in GEMS, SEAP, Near Peer, and CQL programs, which are all intended to provide repeated or long-term engagement in STEM activities at Army labs. Substantial proportions report past participation in GEMS (10%), SEAP (24%), and Near Peer (3%) programs. In addition

[8] $p < 0.05$ with paired samples t test (two tailed); STEM jobs vs. Army/DoD STEM jobs: Mean Diff = 1.494, t = 10.14, $p = .000$, $d = 1.074$ approaching very strong effect; STEM career vs. Army/DoD STEM career: Mean Diff = .1.607, t = 11.13, $p = .000$, $d = 1.180$ very strong effect

17% of CQL apprentices are repeat participants. These data potentially provide evidence for the success of site-based AEOP cross-promotion and recruiting practices.

Mentor demographics. Demographic information collected from 2013 CQL mentor questionnaire respondents are summarized in Table 10. The full data are provided in Appendix C.

CQL mentors were predominantly male (67%) and White or Caucasian (57%). A comparison of 2013 mentor and apprentice gender and race/ ethnicities reveal similar trends, including higher proportions of males and individuals identifying as White or Caucasian.

Of 22 mentor questionnaire respondents, only 1 was a first-time CQL mentor. Nearly half (45%) of mentor respondents had mentored for CQL only once before. The average number of CQL apprentices mentored through the years was 3, ranging from 1 (the current apprentice) to 10 apprentices. Of the 15 mentors, 18% reported being a CQL apprentice in the past. The proportions of new and returning mentors and the range in numbers of apprentices' mentors suggests that CQL has balanced two mechanisms for recruiting Army S&Es: through engaging new mentors annually and by repeated engagement that leverages the knowledge and experience as past CQL mentors.

Table 10. 2013 CQL Mentor Questionnaire Respondent Demographics

Demographic Category	No.	%
Gender		
Female	6	29%
Male	14	67%
Choose not to report	1	0%
Race/Ethnicity		
American Indian or Alaskan Native	0	0%
Asian or Other Pacific Islander[9]	2	10%
Black or African American	2	10%
Hispanic or Latino	1	5%
White or Caucasian	12	57%
Other	1	5%
Choose not to report	3	14%
Past Participation		
Worked as a CQL apprentice	4	18%
CQL apprentices mentored historically	Avg = 3, Range = 1-10	

As CQL endeavors to expand the participation of students from underserved and underrepresented populations in its programs, it might contemplate how to effectively expand inclusion of those same populations in its mentor pool, as

[9] The 2012 demographic category consisted only of Asian, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

access to mentors sharing the same gender or race/ethnicity characteristics has been suggested as a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.[10]

Mentor research. Mentors were asked to describe their field of research with the same broad fields provided in the apprentice questionnaire. The full data are provided in Appendix C.

All but two of the nine STEM or related disciplines listed were represented, those two being environmental science and social science. Mentors most frequently reported conducting research in engineering (43%), followed by chemistry (14%), and physical Science (14%). The most frequently reported mentor field of research—engineering—is consistent with the field of study and career interest reported most frequently by apprentices.

[1010] The 2012 demographic category consisted only of Asian, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

[10] Research is not definitive regarding mentees' access to or matching with role models and mentors of same gender or race/ethnicity. Recent studies suggest that female and minority mentees may prefer same-demographic role models and mentor matches (Syed, et al., 2012), that same-demographic matching can provide greater satisfaction with the mentee-mentor experience and fewer match failures (Spencer, 2007), as well as a range of benefits to mentees including mitigation of stereotypes and higher performance (e.g., due to a reduction of achievement-limiting "stereotype threat") (Aronson & Steele, 2005; Young et al., 2013), positive attitudes and identity toward STEM (Stout, et al., 2011; Young, et al., 2013), and persistence in STEM pathways (Drury, et al., 2011). Other studies have demonstrated that cross-demographic matches can enjoy similar benefits as same-demographic matches under a variety of conditions, including when mentee has access to non-stereotypical role models or have strong perceptions of similarity with a role model or mentor (Cheryan, et al., 2011); when mentee (or mentee parents) prefers cross-demographic matching (Jucovy, 2002); when mentee-mentor partners can effectively navigate cultural issues (e.g., mentor's cultural sensitivity, mentee's cultural mistrust, and shared cultural empathy) (Sanchez & Colon, 2005); when mentees have access to multiple mentors or are embedded in strong protégé communities (Laursen, et al., 2010).For recent studies, authoritive reviews of literature, and recommendations for programming, see the following: Aronson, J., & Steele, (2005) Stereotypes and the fragility of human competence, motivation, and self-concept. In C. Dweck & E. Elliot (Eds.) *Handbook of competence and motivation*. New York: Guilford; Burke, R. and Mattis, M (2007) *Women and minorities in science, technology, engineering, and mathematics.* Northampton, MA: Edward Elgar Publishing; Drury, B., Siy, J. and Cheryan, S. (2011) When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry,* 22, 265-269; DuBois, D.L. Portillo, N., Rhodes, J.E., Silverthorn, N. & Valentine, J. (2011) How effective are mentoring programs for youth? A systematic assessment of the evidence. *Psychological Services in the Public Interest*, 12 57-91; Rhodes, J., Reddy, R., Grossman, J., & Lee, M. (2002) Volunteer mentoring relationships with minority youth: And analysis of same-versus cross-race matches. *Journal of Applied Social Psychology,* 32 (10) 2114-2133; Sanchez, B. & Colon, Y. (2005) Race, ethnicity, and culture in mentoring relationships. In D.L. DuiBois & M.J. Karcher (Eds), *Handbook on Youth Mentoring.* Thousand Oaks, CA: Sage; Stout, J., Dasgupta, N, Hunsinger, M., McManus, M (2011) STEMing the tide: Using in-group experts to inoculate women's self-concept in science, technology, engineering, and mathematics. *Journal of Personal Social Psychology,* 100 (2) 255-270; Syed, M, Goza, B., Chemers, M. & Zurbriggen, E. (2012) Individual differences in preferences for matched ethnic mentors among high-achieving ethnically diverse adolescents in STEM. *Child Development,* 83 (3) 896-910; Young, D., Rudman, L., Buettner, H., & McLean, M. (2013) The influence of female role models on women's implicit science cognitions, *Psychology of Women Quarterly*, 37 (3) 283-292.

Actionable Program Evaluation

Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. This section highlights information outlined in the Satisfaction & Suggestions and Goal 1 and 2 Program Efforts section of Tables 7 and 8.

A focus of the Actionable Program Evaluation are efforts toward the long-term goal of CQL and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. Thus, it is important to consider how CQL is marketed and ultimately recruits participants, the factors that motivate them to participate in CQL, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. In the sections that follow, we report perceptions of apprentices and mentors, in an effort to both understand current efforts and recommend evidence-based improvements toward achieving outcomes related to AEOP and program objectives.

Marketing and Recruiting Underserved Populations

The CQL manager, ASEE, reported conducting targeted marketing in communities and organizations serving high populations of minority and low-income students, including: email blasts to previous apprentices of the Office of Naval Research SEAP and Naval Research Enterprise Internship Programs and promotional materials sent to career centers at more than 30 colleges and universities. Site-based marketing and recruitment included staff participation in career events at local historically black universities and other outreach to surrounding universities serving underrepresented populations.

Online focus groups with apprentices asked why they chose to participate in CQL, including any personal connections that led them to CQL (or to a specific site or mentor), or any past experience participating in this or other AEOPs. Their responses revealed a variety of ways in which they became aware of and involved in CQL, which helps us to understand how CQL ultimately attracts apprentice participants. Mentors were asked how they became connected with their apprentice. This helps us to understand how participants are ultimately recruited and/or selected at the site level.

More than a third of apprentice interviewees learned of CQL through influential acquaintances (friend, family, family friends, or university professor) having a connection to the CQL site, program, or mentor. This finding is consistent with the 37% of apprentice questionnaire respondents that report a family member or family friend works at the CQL site. More than a third of apprentice interviewees learned of CQL through GEMS, SEAP or Near Peer programs at the site. Similarly, apprentice questionnaire respondents reported previous participation in GEMS (10%), SEAP (24%), and Near Peer (3%). A small number of apprentices learned of CQL through their participation in a non-AEOP program offered at the CQL site. Fewer apprentices came to CQL independently (e.g., through the CQL or AEOP website) or through university advertisements.

Nearly half of mentor interviewees reported selecting their apprentices that were recommended by or related to a personal or professional acquaintance (e.g., child of another staff member, student recommended by a school or university contact). About the same number of mentor interviewees reported being assigned to an apprentice by the CQL coordinator or selecting from an unknown ("un-vetted") applicant pool. Several mentor interviewees described having "more success" with apprentices that had been previously "vetted" through personal or professional connections.

These findings suggest that CQL achieves its objective of providing opportunities for continued STEM enrichment and association of SEAP, GEMS, and other AEOP alumni with DoD labs, as well as allow new college students the opportunity to engage with DoD laboratories. However, they also suggest that an existing connections to the CQL site, program, or mentor are the more likely conduits by which those new college students learn about and are ultimately selected for CQL apprenticeships.

Motivating Factors for Participation

Focus groups elicited apprentices' and mentors' motivation to participate in CQL. The following trends emerged from their responses.

Motivating factors for apprentices. Past experience in AEOP programs motivated apprentices' participation. Specifically, apprentices cited their own positive experiences in GEMS, SEAP, and Near Peers and a desire to continue working at the same facility motivated participation in CQL. Two interviewees were returning to the CQL site to continue research from the previous CQL apprenticeship (17% of questionnaire respondents reported similarly). Opportunities for professional growth motivated participation in CQL. Apprentices anticipated that CQL would help them progress in their intended STEM pathways, including: clarifying their education and career goals; building research skills in an authentic laboratory setting; gaining experience with new materials, equipment, and techniques; applying their educational training; and building applications or resumes.

Motivating factors for mentors. Mentors also expressed a variety of factors that motivated their participation. A number of mentors reported that their past participation as a SEAP or CQL mentor or GEMS instructor motivated their participation in 2013. Specifically, several mentors wanted to re-engage CQL apprentices in the research project for a second or third year. In addition, some mentors wanted to help referred students secure a CQL apprenticeship. Other mentors described having project needs they deemed appropriate for CQL apprentices. One mentor was motivated by teaching in the research setting; subsequently, the apprentices "blew [his] expectations out of the water."

Apprentices chose CQL to re-engage with the Army laboratory or mentor to advance their STEM pathways. Mentors seek opportunities to engage with STEM learners in their work.

Mentor Capacity

CQL's first objective is to nurture interest and provide STEM research experience for college students and recent graduates contemplating further studies. The nature and quality of mentoring provided is a critical factor to maximizing students' participation in these opportunities and sustaining or inspiring their interest in future STEM work. Understanding mentor

activities from the perspectives of apprentices and mentors can inform programmatic improvement for sustaining apprentices' interest and participation in STEM.

All of the apprentice and mentor assessments included a number of closed-scale and open-ended items addressing mentor activities. The next section summarizes some of these data, including apprentice and mentor perceptions of general mentor activities, and mentors' reflections about mentoring apprentices from underserved populations and mentoring apprentices about AEOP opportunities and Army/DoD STEM careers.

General mentor activities. Mentor and apprentice questionnaires included five items to elicit perceptions of general mentor activities related to productively engaging apprentices in STEM research. Eight additional items addressed mentor activities related to supporting apprentices' educational and career pathways. For all items, mentors and apprentices responded on a 6-point scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree." Charts 4 and 5 (on the next page) summarize the proportions of mentors and apprentices that selected "Agree" or "Strongly Agree" for each item. The full data are summarized in Appendices B and C. Table 11 summarizes the statistical comparisons of the two perspectives for the educational and career pathways items.

Chart 4 illustrates that the majority of apprentices (71%-93%) and mentors (59%-77%) report that each of these basic mentor activities relating to engagement in STEM research occurred. Only a small proportion of apprentices (1%-6%) and mentors (0%-5%) strongly disagreed or disagreed that any of these mentor activities occurred. No statistically significant differences were detected in apprentice and mentor perceptions; though teaching apprentice how to work effective in the laboratory approached significance, with a weak effect.[11]

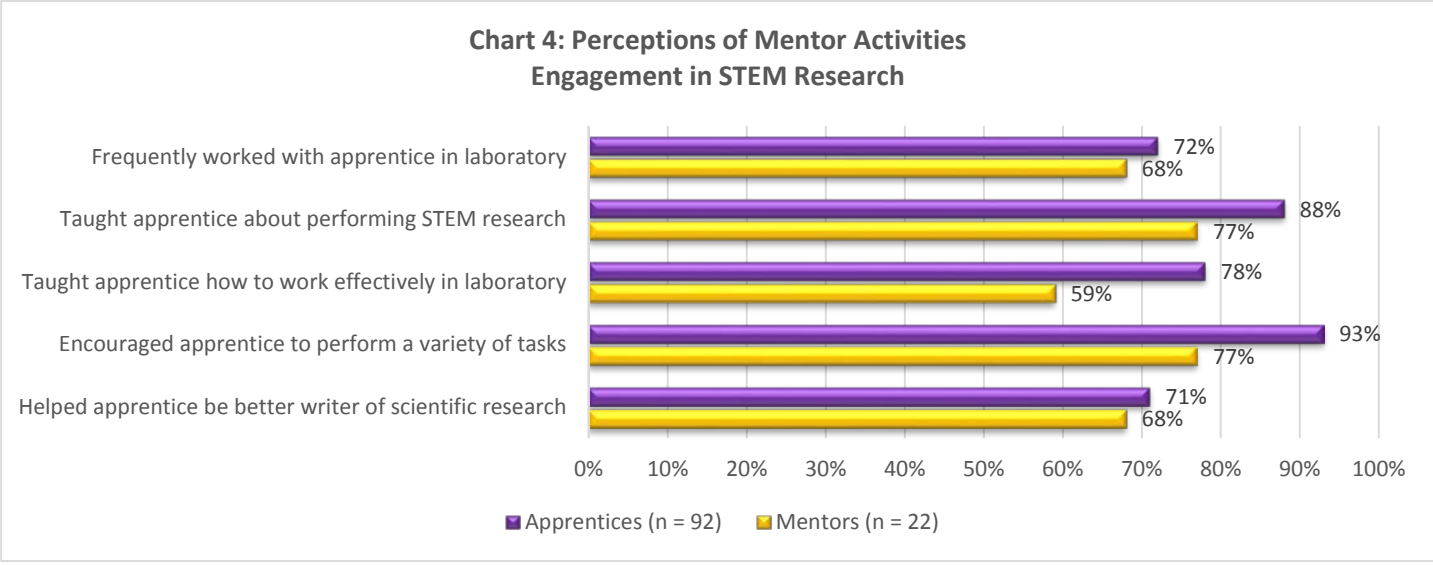


Chart 5 shows that for most activities relating to supporting educational and career pathways, the majority of apprentices (63%-80%) perceived experiencing these mentor activities. However, yet less than half of mentors perceived providing

[11] $p > 0.05$ with independent samples t test (two tailed); apprentices vs. mentors: Mean Diff = .39, $p = .07$, $d = .34$ weak effect

these opportunities to apprentices, except for providing a letter of reference (85%) and speaking about career interests (59%). In the case of educational and career pathways items, a larger proportion of apprentices (4%-25%) and mentors (5%-65%) strongly disagreed or disagreed that any of these mentor activities occurred. The statistical comparison shown in Table 5 reveals significant differences for all but two items with effects ranging from small (e.g., steps to achieve professional goals, *d* = .64) to very large (helped draft CV/resume, *d* = 1.10).

Chart 5: Perceptions of Mentor Activities Supporting Educational and Career Pathways

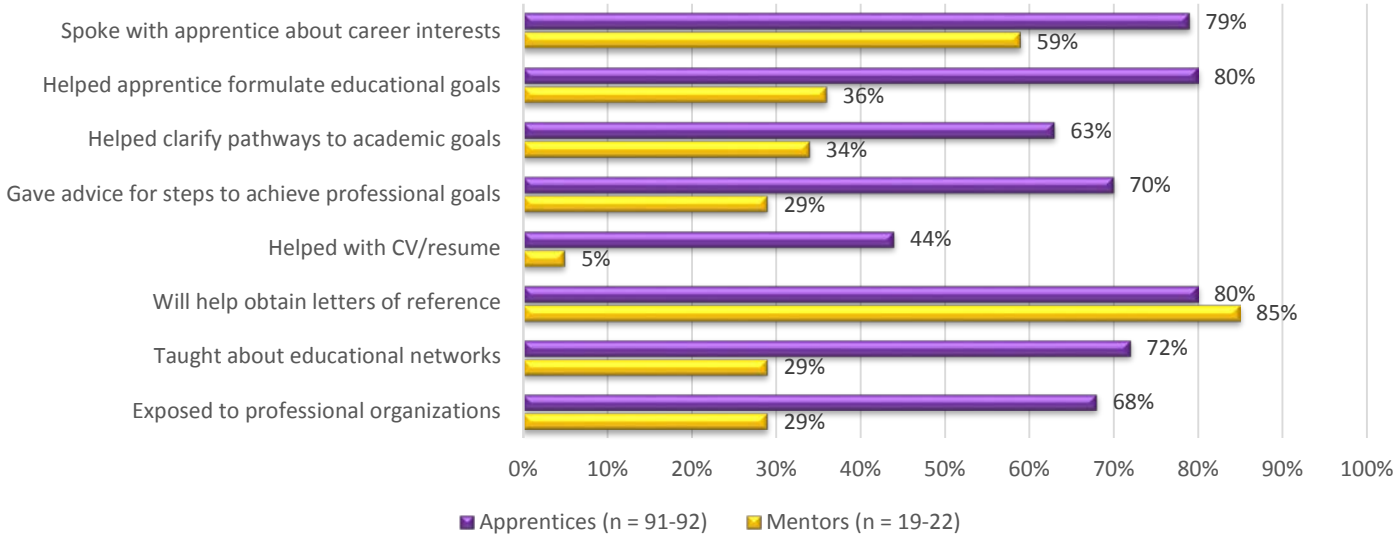


Table 11. Perceptions of Mentor Activities, Comparison of Apprentice vs. Mentor Perceptions

Item	Apprentice Avg. (SD)	n	Mentor Avg. (SD)	n	Mean Diff.	*p*	*d*
Spoke with apprentice(s) about career interests	5.03 (1.09)	92	4.64 (1.18)	22	**.39**	.14	.35
Helped apprentice(s) to formulate their educational goals	5.05 (1.11)	92	3.91 (1.06)	22	**1.14***	.00	1.04
Helped apprentice(s) clarify their educational goals and pathways	4.82 (1.05)	92	4.00 (1.10)	21	**.82***	.00	.77
Provided guidance to apprentice(s) about the steps they will need to achieve their professional and educational goals	4.89 (1.18)	91	4.14 (1.11)	21	**.75***	.01	.64
Helped apprentice(s) draft their CV/Resume	4.00 (1.56)	91	2.35 (1.09)	20	**1.65***	.00	1.11
Will write or help my apprentice(s) obtain letters of reference	5.19 (1.06)	91	5.05 (1.12)	21	**.14**	.59	.13
Introduced apprentice(s) to educational and professional networks that will help them in the future	4.88 (1.27)	92	3.95 (1.24)	21	**.93***	.00	.74
Exposed apprentice(s) to professional organizations that can help them pursue their career/educational goals	4.82 (1.30)	92	3.52 (1.36)	21	**1.30***	.00	.99

NOTE: ** = p < .05 with independent samples t-test (two-tailed)*

A trend was noted in both apprentice and mentor focus groups that provides a plausible explanation for these differences in apprentice and mentor perceptions. Both apprentices and mentors reported that other laboratory personnel (e.g., laboratory managers, technicians, and postdoctoral fellows) contributed substantially to the day-to-day mentoring of CQL apprentices, sometimes more so than the designated Army S&E mentor. Both apprentices and mentors shared generally positive sentiments about this collective approach to mentorship, it could also be a contributing factor in these significant differences noted in apprentice and mentor perceptions of mentor activities. Apprentices may be reporting on collective mentorship provided by the laboratory or project team, while Army S&E mentor responses represent only their contribution.

When asked in focus group to describe the mentoring received or provided in a typical day, apprentice and mentor interviewees most frequently described efforts to engage apprentices in the research, including mechanisms to:

- review apprentices' work and provide constructive feedback;
- ground apprentices' laboratory-based work in scientific principles and practices (e.g., teaching concepts or equations, scaffolds for recording observations and data, collaboratively reviewing results, and coaching scientific writing); and,
- train apprentices to conduct laboratory tasks and procedures.

More than one half of CQL apprentice interviewees also described speaking with mentors about education and career plans. Similarly, mentors described discussions (and ongoing communication after the CQL apprenticeship) with apprentices about professional networking, interview preparation, and general career advice.

In short, CQL mentors use a team-based approach to engaging their apprentices in STEM research and supporting their educational and career pathways. Data suggest that Army S&E's mentors are more focused on engaging apprentices in the research to be accomplished, while other mechanisms (including mentorship from the laboratory team) serve to support apprentices' educational and career pathways. Improved reliability of mentor data and matched mentee-mentor data could be used to test this explanation in future evaluations.

Mentoring about AEOP opportunities. The mentor assessments asked about strategies used, challenges faced, and ways in which CQL could support mentors in educating apprentices about AEOP opportunities. No more than 7 mentors responded to any of the questionnaire items. Four mentors reported providing information to the CQL apprentice about the SMART scholarship program. The other mentor questionnaire respondents reported they were not familiar with other AEOP programs. Similarly, mentor interviewees almost unanimously reported being unaware of AEOPs, especially those offered outside of the CQL site. Mentors generally cited a lack of awareness of AEOPs, as well as lack of resources and knowledge of existing expectations to educate apprentices about AEOPs, as the challenges preventing them from meeting this objective.

In online questionnaires and in focus groups, mentors suggested the following programmatic revisions for supporting them in educating their apprentices about AEOP initiatives, including providing:

- more informational resources about other AEOP initiatives that mentors can pass to apprentices;
- same informational resources but directly to apprentices in their arrival or welcome packet;

- educational opportunities to increase mentor awareness about AEOP initiatives; and
- clear expectations that mentors should be educating apprentices about AEOPs.

Questionnaires included additional items which allow for comparisons between mentor and apprentice perceptions about efforts to expose students to AEOP opportunities, and interest generated from that exposure. These are reported in the Outcomes Evaluation section.

Mentoring about Army/DoD STEM careers. The mentor assessments asked about strategies used, challenges faced, and ways in which CQL could support mentors in educating apprentices about STEM and specifically Army/DoD STEM careers. Mentors used different strategies in mentoring students about STEM careers, including: highlighting the research of different Army directorates or other DoD institutions, fostering apprentices' collaboration with other Army S&Es and laboratory personnel, providing guidance for the application process and career possibilities for Army physicians, sharing job search options, and other informal conversations about STEM education and career pathways. Some questionnaire respondents and interviewees felt that the laboratory experience is education in and of itself about STEM jobs and careers with the Army.

Mentors cited a few challenges in educating apprentices about STEM and Army/DoD STEM careers, including: furloughs (e.g., lack of time to discuss careers when furloughed and furloughs impart negative perceptions of Army/DoD work), lack of awareness of and resources for educating about STEM careers, and feeling unqualified to speak about other jobs/careers other than their own or those related to their work at the CQL site.

In the mentor focus groups the recommendation was made for CQL to provide resources that mentors could share with apprentices to introduce Army/DoD STEM careers. Most of the recommendations provided in the mentor questionnaire pertained less to supports for helping mentors educate apprentices about Army/DoD STEM careers, and instead focused on CQL programming that could increase visibility of Army/DoD STEM professionals: reframing CQL as a tri-service program, hosting final presentations at Uniformed Services University to engage WRAIR researchers, and streamlining in-processing to allow greater time for research (and presumably, discussion of educational and career pathways).

Questionnaires included additional items which allow for comparisons between mentor and apprentice perceptions about efforts to expose apprentices to STEM and Army/DoD STEM careers, and interest generated from that exposure. These are reported in the Outcomes Evaluation section.

Perceptions of CQL

Assessments elicited apprentice and mentor perceptions of CQL, including perceived value of CQL, contributions to educational and professional pursuits (apprentices only), successes and challenges of the CQL experience (mentors only), overall satisfaction with program activities and areas for improvement.

Value of CQL. Apprentices and mentors were asked in focus groups what they perceive as the value of the CQL program. The apprentice questionnaire also asked what they perceived as the most valuable part of the research project or final presentation.

Apprentices described a range of benefits to them, including

- Authentic, real-world research experiences within a professional research setting and unlike typical school experiences;
- Expanding STEM competencies (e.g., deepening understandings of the research process, gaining skills in both conducting and communicating research to others, learning to collaborate, and opportunities to apply knowledge learned previously in school);
- Opportunities to advance their STEM pathway (e.g., learning how to work in a professional environment, building application or resume for graduate school and prospective employers);
- Access to effective mentorship (e.g., opportunities for autonomy and one-on-one learning in research, quality mentor feedback, collaboration and networking with researchers, opportunities for apprentices to become better mentor and/or teacher themselves).

Mentor interviewees most frequently described the ways in which CQL benefitted participants. Mentors reported that these programs:

- Engage apprentices in authentic research experiences and opportunities to develop hands-on and academic research skills in a professional laboratory setting, which are not possible in school;
- Help apprentices clarify and/or advance their STEM pathway (e.g., decisions about education or career goals, building application or resume); and
- Improve apprentice confidence in research skills and abilities.

Evaluators also elicited CQL's value in terms of its benefit to mentors or to their laboratories. Mentors reported that during CQL:

- Apprentices were low-cost yet highly effective members of the lab, especially "post-baccs;"
- Mentors were able to "pay it forward" (a common phrase used by mentors to describe repaying their past mentor(s)' efforts by mentoring others in turn);
- Mentors developed or expanded their teaching and mentoring skills; and,
- Mentors found it especially rewarding when high-risk or disadvantaged apprentices succeeded.

Contributions to educational and professional pursuits. The apprentice questionnaire asked apprentices to describe the ways in which CQL contributed to their educational or professional pursuits. Focus groups participants were also asked about the impact of their mentor on future aspirations. The major trends in their responses are provided below, listed from the most to the least cited responses. A summary of narrow themes and example responses from the questionnaire related to each broad theme is provided in Appendix B.

- Developing and expanding a range of both hands-on and academic knowledge, skills, and abilities needed to conduct, think about, and communicate about authentic STEM research;
- Exploring, clarifying, or advancing apprentices STEM pathway;

- Gaining confidence in ability to conduct research and to adapt to research work environments;
- Effective mentorship from mentors and peers involved with CQL;
- Better understanding of DoD's contributions to society; and
- Greater desire for future career to include helping others.

In focus groups apprentices also credited their mentors with cultivating interest in mentoring STEM apprentices in the future, with exposing them to a range of research fields and careers, helping them to clarify their educational and career goals, and preparing them for a job at the CQL site.

Successes and challenges of CQL. The questionnaire asked mentors to report successes and challenges they or their apprentices experienced. Of 8 respondents, mentors perceived apprentice successes, including that apprentices developed as STEM researchers and provided laboratory techniques training to other employees.

Some mentors described challenges they encountered, including

- Delayed access to computers and software for apprentices to use;
- Stipend payment and travel reimbursement issues (e.g., checks vs. direct deposit, timing of payment, difficulties with travel reimbursement); and,
- Scheduling of summer intern presentations (e.g. round 1 presentations occur in mid-July, while apprenticeship runs until late August).

Some mentors provided additional information about their apprentices' or his or her research project. These mentor quotations illustrate the quality of CQL apprentices and their successes working in Army laboratories:

> *"[My apprentice] is smart, capable, inventive, can work independently, and eager to achieve and produce results."*
>
> *"Her sense of integrity, duty, and commitment demonstrates maturity well beyond her age."*
>
> *"[My apprentice's] novel work warrants publication in a peer-reviewed journal. It will advance testing methods for the field."*
>
> *"[My apprentice] went way above my expectations and proved to be a great asset to our research project."*

Overall satisfaction and areas for improvement. Apprentices and mentors were asked several items to gauge their overall satisfaction with CQL. These items also provided opportunity for participants to voice concerns and identify areas for improvement. Table 12 summarizes these items.

Table 12. 2013 Assessment Satisfaction and Improvement Items	
Assessment	**Item**
Apprentice and Mentor Focus Groups	If you had one minute to talk to an Army decision maker about CQL, what would you say?
Apprentice Questionnaire	Given the opportunity, would you participate in CQL again? Why or why not?

Most mentors wanted to share with Army decision makers the benefits that CQL affords to apprentices, mentors, and laboratories. In addition to the benefits already listed by mentors as the value of CQL (see above section), mentors suggested that

- the Army facility and resources are truly unique in what they can offer apprentices;
- apprentices have a better understanding of and appreciation for the work of Army/DoD after their apprenticeship; and
- apprentices offer fresh perspectives at CQL sites;

Mentors also would share their recommendations for improving CQL's impact, including that CQL should

- improve visibility of CQL programs;
- expand CQL's outreach to other demographics and outside of the DoD community;
- reduce the administrative "burden" associated with these apprenticeships, or provide a site- or program-specific liaison to provide support to mentors for completing this work efficiently and accurately; and
- provide guidance for handling vacation time for apprentices, especially those apprentices in 6, 9 or 12 month appointments.

Most CQL apprentices spoke highly of their experience. CQL apprentices would share with Army decision makers the many benefits shared as the value of CQL (see above). In addition they highlighted these areas for potential improvement:

- mentee-mentor matching process (e.g., lack of work available in the mentors' laboratory, personality mismatches negatively impacted the experience);
- in-processing and other administrative tasks (e.g., CAC card) detracted from the time available for research;
- notifications of the apprenticeship were distributed too late to make alternate plans (e.g., if rejected);
- limited promotion of CQL and other programs at the site (e.g., awareness most consistently through personal connections);
- limited to performing a laboratory task rather than conducting research; and
- professional development needed for mentors.

Outcomes Evaluation

The evaluation of CQL included measurement of several outcomes relating to AEOP and program objectives aligned with AEOP Goal 1: STEM Literate Citizenry. Toward AEOP Goal 1, the evaluation measured the following: apprentices' perceptions of engagement in STEM activities in CQL; apprentices' and mentors' post-CQL perceptions of apprentices' STEM competencies; apprentices' interest in future STEM engagement; and apprentices' awareness and interest in educational and career opportunities in Army STEM.

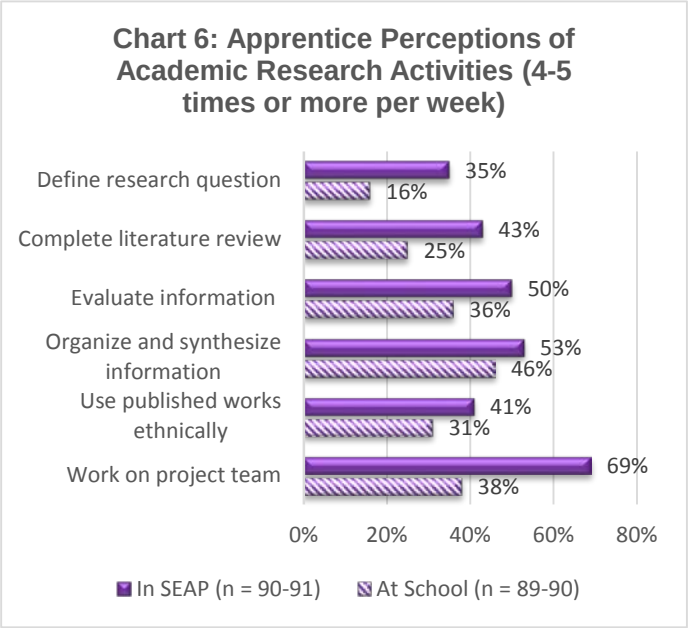
STEM Competencies

STEM competencies are necessary for a STEM-literate citizenry. STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important for those engaging in STEM enterprises, but also for all members of society, as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. Apprentice questionnaires measured apprentices' and mentors' perceptions of students' engagement in authentic STEM activities, apprentice's self-reported change in confidence in their STEM competencies, and mentors' expert assessment of apprentices' STEM competencies. These measures also align with CQL Objective 4: To increase participant knowledge in targeted STEM areas and develop their research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research.

Engagement in authentic STEM activities. Twelve items measured apprentices' perceptions of opportunities to engage in STEM activities in CQL as compared to in school. Six of the items included minds-on or academic research activities, such synthesizing and evaluating information. Six of the items included hands-on research activities, such as using equipment and procedures. Apprentices responded on a 6-point frequency scale of 1 = "Never," 2 = Once per week," 3 = "2-3 times per week," 4 = 4-5 times per week," 5 = "Every day," and 6 = "Multiple times per day". Mentors responded to a similar battery of 9 items using the same response scale.

Charts 6 and 7 on the next page summarize the proportions of apprentices reporting engaging in each activity 4-5 or more times per week or more in CQL and at school, in their undergraduate or graduate STEM lecture and laboratory courses. More detailed data summaries are provided in Appendix B. A statistical comparison of the frequency with which students report engaging in STEM activities in CQL and at school, is provided in Table 13.

As illustrated in Charts 6 and 7, the proportion of apprentices reporting engaging in these activities 4-5 or more times per week during CQL exceeds 29% for all activities (29%-71%). Smaller proportions of apprentices engaged in these kinds of activities at school with similar frequency (16%-46%). Apprentices most frequently reported safely handling equipment and materials (71%), working on a project team (69%), and using advanced equipment (61%) and measurement techniques (61%). On average, students engaged in these activities more than 2-3 per week in CQL (Avg ~3.6/6.0) and less than 2-3 times per week at school (Avg ~2.8/6.0).



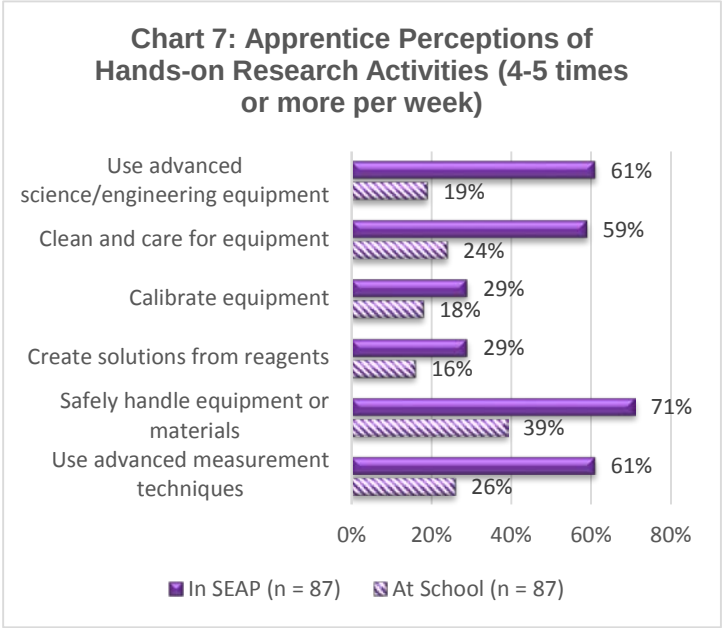


Table 13. Engagement in STEM Activities, Matched Cases Comparison At school vs. In CQL

Item	At school Avg. (SD)	In CQL Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I had to define a research question or thesis and determine its critical concepts	2.42 (1.40)	3.21 (1.53)	89	**.798***	4.87	.000	.516
I had to use academic search strategies (e.g., databases and journals) to complete a literature review	2.74 (1.50)	3.45 (1.65)	89	**.708***	3.64	.000	.386
I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	3.12 (1.52)	3.68 (1.65)	90	**.556***	3.21	.002	.338
I had to organize and synthesize information across academic sources	3.47 (1.55)	3.73 (1.64)	89	**.258**	1.57	.119	.167
I had to determine appropriate ethical and legal uses of published academic research for my own work	2.97 (1.64)	3.36 (1.74)	90	**.389**	2.22	.029	.234
I had to work as part of a team on research projects	3.33 (1.60)	4.25 (1.75)	89	**.921***	4.53	.000	.480
I used advanced science or engineering equipment	2.92 (1.43)	4.14 (1.74)	87	**1.221***	5.90	.000	.636
I cleaned and cared for the equipment in a science or engineering laboratory	2.73 (1.59)	3.91 (1.89)	87	**1.174***	5.43	.000	.585
I calibrated laboratory equipment for experimentation	2.31 (1.50)	2.77 (1.75)	87	**.453***	2.32	.023	.250
I created solutions from reagents in preparation for experimental procedures	2.21 (1.47)	2.62 (1.95)	87	**.407**	1.92	.058	.208
I used proper safety procedures when handling equipment and material in the lab	3.40 (1.58)	4.53 (1.73)	87	**1.140***	5.21	.000	.561
I employed advanced measurement techniques in science or engineering procedures	2.87 (1.57)	4.05 (1.88)	87	**1.174***	5.32	.000	.574

NOTE: ** = p < .05 with paired samples t-test (two-tailed)*

Table 13 reveals that these differences between CQL and school are statistically significant ($p < .05$) across most of the hands-on activities. The magnitude of these significant differences range from small ($d = .250$) to moderately large ($d = .636$). For example, the difference in calibrating equipment in CQL versus at school is real but relatively small ($d = .250$). The difference in using advanced science or engineering equipment in CQL versus at school is moderately large ($d = .636$). The statistical comparisons also reveal that CQL had a slightly greater effect in providing apprentices with opportunities for hands-on research activities than it did the academic (minds on) research activities. In other words the magnitude of the differences between CQL and school was slightly larger for hands-on activities than on academic research activities. [12]

STEM skills and abilities. Seven items measured apprentices' self-reported gains in confidence with a range of academic and hands-on research skills and abilities, as a result of the CQL program. In addition, six rubrics in the CQL mentor questionnaire leveraged mentors' expertise as researchers and observations of apprentices during the program to provide expert ratings of apprentices' academic and hands-on research skills and abilities. The STEM skills and abilities assessed by both apprentices and mentors have sufficient overlap to allow for some triangulation of findings. The apprentice items and mentor rubric items (defined at the expert level) are summarized in Table 14.

[12]Recent policy recommendations call for coordination of STEM learning across formal (e.g., K-12, college) and informal (e.g., designed, outreach) settings to advance the national goal of a STEM-literate citizenry. Shared STEM standards and metrics are central to those coordinated efforts (NSB, 2007; U.S. DoE, 2007; PCAST, 2010; CoSTEM 2013). PCAST (2010) calls for widespread support of the state-led standards movement, *Next Generation Science Standards* (NGSS), not only among all K-12 agencies, but by academic, non-profit, business and other sectors providing outreach to students and teachers. U.S. DoE (2007) and more recently CoSTEM (2013) call for measurement of both learning and affective outcomes in STEM engagement investments. U.S. DoE (2007) and NRC (2009) have suggested similar frameworks defining those learning and affective outcomes across STEM engagement investments, and they recommend widespread adoption of such frameworks to support the ongoing assessment of the nation's progress toward achieving its goal of a STEM-literate citizenry. Although the evaluation frameworks preceded the NGSS, they generally reflect NGSS' vision (and supporting evidence base) for authentic and inspiring STEM learning through the symbiotic development and application of core disciplinary ideas, cross-discipline concepts, and science and engineering practices. Those practices include: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computations thinking; constructing explanations and designing solutions; engaging in argument from evidence; obtaining, evaluating, and communicating information (e.g., NGSS Lead States, 2013). Similar notions of learning are recommended at the college level (AAAS 2009; NRC, 2003). While the field of science education has been more prolific in its advancement of these policy recommendations, other teacher associations, accrediting organizations, and multi-sector partnerships have recommended similar frameworks that call for similar learning experiences and outcomes in those fields (e.g., ABET, 2011; NCTM, 2000, P21, 2010). Accreditation Board for Engineering and Technology (ABET, 2011) *Criteria for Accrediting Engineering Programs*; American Association for the Advancement of Science (AAAS, 2011) *Vision and Change in Undergraduate Biology Education: A Call to Action*. Washington, DC: Author; Committee on STEM Education National Science and Technology Council (CoSTEM, 2013) *Federal Science, Technology, Engineering, and Mathematics Education 5 Year Strategic Plan*. Washington, DC: Author; National Council for Teachers of Mathematics (NCTM, 2000) *Principles and Standards for School Mathematics*; National Research Council (NRC, 2003) *Transforming Undergraduate Education for Future Research Biologists.* Washington DC: The National Academies Press; National Research Council (NRC, 2009) *Learning Science in Informal Environments: People, Places, Pursuits.* Washington DC: The National Academies Press; National Science Board (2007) Science, technology, engineering, and mathematics (STEM) education issues and legislative options. In R. Nata (Ed), *Progress in education* (vol. 14, pp. 161-189). Washington, DC: Author; NGSS Lead States (2013) *Next Generation Science Standards: For States, By States.* Washington DC: The National Academies Press; Partnership for 21st Century Skills, *Framework for 21st Century Learning;* President's Council of Advisors on Science and Technology (PCAST, 2010) *Prepare and Inspire: K012 Education in Science, Technology, Engineering and Math for America's Future*. Washington, DC: Author; U.S. Department of Education (U.S. DoE, 2007) *Report of the Academic Competitiveness Council*. Washington, DC: Author.

Table 14. Apprentice and Mentor Assessments of STEM Skills and Abilities	
Apprentice Confidence Item	**Mentor Rubric Item: Expert Level**
I am more confident in my ability to complete academic literature reviews for my own research projects	**Information literacy skills/abilities:** Expertly determines, searches for, and accesses needed information. Synthesizes and uses information from credible sources in a highly ethical manner.
I am more confident in my ability to formulate hypotheses and design experiments to test them	**Scientific reasoning skills/abilities:** Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research.
I am more confident in my ability to effectively and safely use a science or engineering laboratory I am more confident in my ability to perform equipment calibration and perform complex laboratory techniques	**Laboratory skills/abilities:** Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed. **Data Collection Techniques:** Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques.
I am more confident that I can analyze data and understand the results of an experiment I am more confident that I can identify and account for limitations and assumptions when formulating conclusions	**Quantitative literacy skills/abilities:** Expertly converts and interprets quantitative information into an accurate set of results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation.

Apprentices responded to items on a 6-point scale of 1 = “Not at all like me” to 6 = “Just like me.” In contrast, mentor rubrics defined a development continuum on a scale of 1 (reflecting novice behaviors) to 6 (reflecting expert behaviors) unique to each STEM skill or ability. Actual scales and data from each mentor rubric items are provided in Appendix C. For ease of visualizing mentor rubric responses here, we will assign a more generic scale across all of the rubrics of 1 = “Novice,” 2 = “Near novice,” 3-4 = “Developing expertise/supervision needed”, 5 = “Near expert,” 6 = “Expert.” The rubrics were completed for each apprentice mentored, so the “n” represents the number of apprentice assessments conducted by mentors, and is, therefore, greater than the total number of mentor questionnaire respondents. Charts 8 and 9 summarize apprentices’ and mentors’ responses to the STEM Competency items.

Chart 8: Apprentice - More Confidence in STEM Competencies (n = 87)

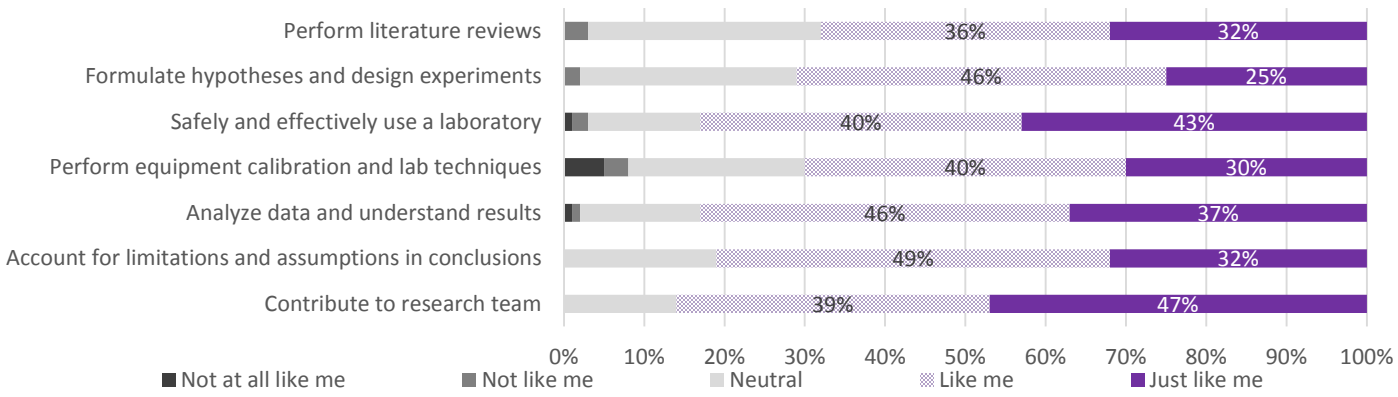
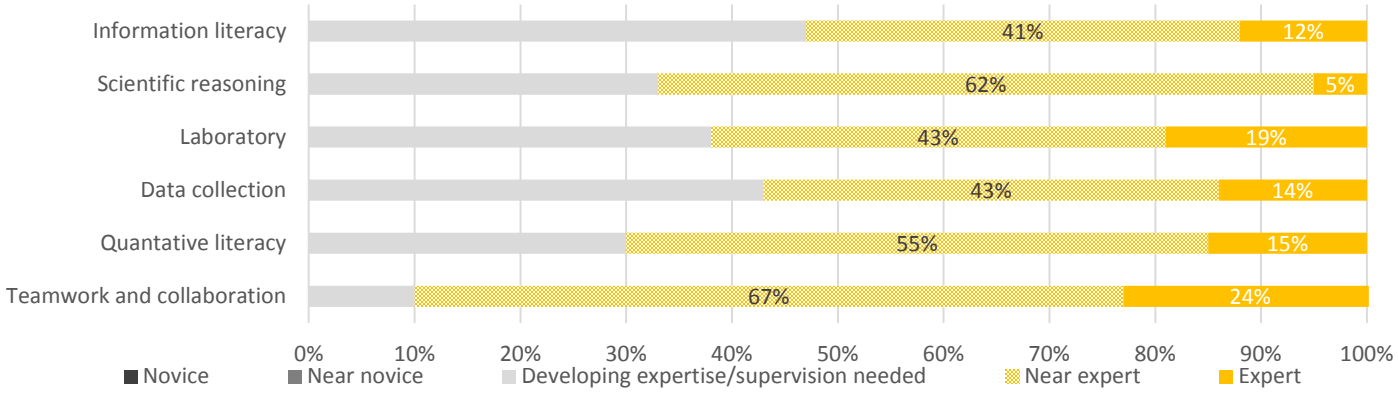


Chart 9: Mentor - Assessment of Apprentice STEM Competencies (n = 21)



From Chart 8, the majority of apprentices (68%-85%) perceived growth in their confidence across the range of skills and abilities. Larger proportions of apprentices' perceived gains in their confidence to safely and effectively use the laboratory (85%), to analyze data and understand results (83%), to contribute to the research team (83%), and to account for limitations and assumptions in conclusions (81%).

Chart 9 shows that the majority of mentors rated their apprentice's skills and abilities in the near expert or expert levels of the development continuum for all skills and abilities (53%-91%). Mentors gave higher proportions of near expert and expert ratings for apprentices' teamwork and collaboration (91%) and quantitative literacy (70%) skills and abilities. Average ratings generally approach near expert across all skills and abilities (4.71-5.14/6.0).

There is considerable agreement between perceptions of apprentice growth in confidence and mentor assessment of STEM skills and abilities. For example, using the alignment of apprentice and mentor items provided in Table 13, we observe higher ratings in the including in the two highest rated items by each participant group (those associated with teamwork and collaboration and quantitative literacy in the mentor rubrics) and the two lowest rated by each participant group (associated with data collection and information literacy in the mentor rubrics). Taken together, we would conclude that students perceived growth in their STEM skills, and mentor assessment of their performance potentially corroborates those perceptions. Apprentices' perceived growth and mentor rubric ratings are also consistent with what we might expect given the frequencies students reported conducting these activities in CQL in the previous section. For example, teamwork and collaboration occurred most frequently; subsequently, it was perceived as the largest growth area according to apprentices and highest performance area according to mentors.

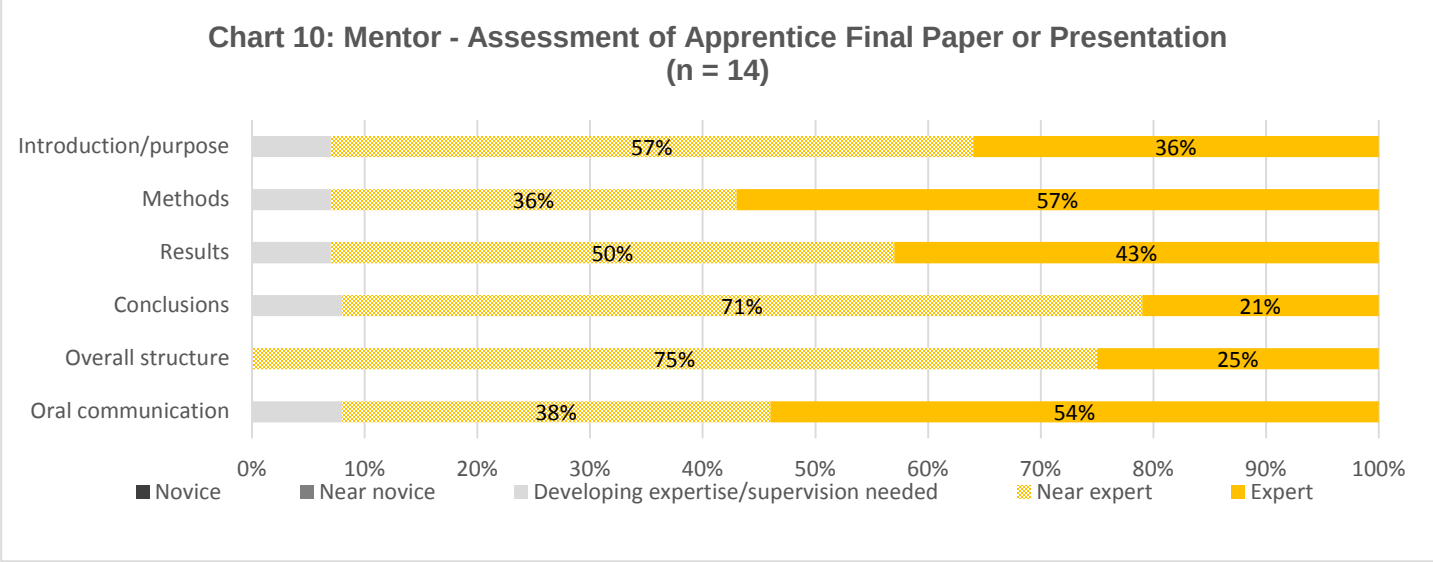
Final paper or presentation. Additionally, six rubrics were given to mentors to rate the quality of their apprentice's final research paper or presentation. Each rubric represents one of six dimensions of typical of STEM research papers or presentations. Much like the aforementioned mentor rubrics, each rubric defined a development continuum on a scale of 1, reflecting novice behaviors, to 6, reflecting expert behaviors, unique to each component of the research paper or presentation. Table 15 summarizes each dimension as it is defined at the expert level.

Table 15. Mentor Assessments of Final Paper or Presentation
Mentor Rubric Item: Expert Level
Introduction/Purpose: Completely Identifies and articulates the purpose of the research. Fully understands and connects with existing research.
Methods: Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report.
Results: Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts.
Conclusions: Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond finding to guide future research.
Overall structure: Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labelled and clear. Grammar is impeccable.
Oral Communication: Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility.

Only 14 mentors responded to these rubrics. Chart 10 summarizes mentors' responses to the Final Paper or Presentation rubrics. For ease of visualizing mentor rubric responses here, we will again assign a more generic scale across all of the rubrics of 1 = "Novice," 2 = "Near novice," 3-4 = "Developing expertise/supervision needed", 5 = "Near expert," 6 = "Expert." Actual scales and data from each mentor rubric items are provided in Appendix C.

Chart 10 shows that these mentors rated all six components of their apprentices' final research project very highly, with 92%-100% providing near expert or expert ratings for each component. The average apprentice received a rating exceeding near expert (5.0/6.0) for all components of their research program (Avg. 5.15-5.5/6.0). These data suggest that

most CQL apprentices not only conduct research, but are also capable of producing high level research papers and presentations within the Army laboratories where they worked.



Future STEM Engagement

The ideology of exposing students to different real-world applications and careers employing STEM early in a students' academic career is rooted in the belief that exposing students might unearth hidden curiosity and passion that students never knew existed. Separate studies from University of Indiana[13] and University of Virginia[14] found that exposure to STEM as adolescents peaked immediate interest in near-term STEM-related pursuits and had a significant effect on future pursuit of STEM degrees and careers, respectively. Not only does CQL aim to inspire and provide information to apprentices about opportunities for their own STEM enrichment, they aim to inform apprentices about ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.

Eleven items[15] in the CQL apprentice questionnaire measured apprentice attitudes toward STEM, CQL, and future STEM activities after their experience of participating in CQL.

[13] Alexander, J. M. & Johnson, K. E. (2012) Longitudinal analysis of the relations between opportunities to learn about science and the development of interests related to science. *Science Education 96 (5)* 763-786

[14] Dabney, K. P., Tai, R. H., Almarode, J.T., Miller-Friedmann, J.L., Sonnert, G., Sadler, P. M. & Hazari, Z. (2012) Out of school time science activities and their association with career interest in STEM. *International Journal of Science Education 2 (1)* 63-79.

[15] Three items are not described here: "I enjoyed the hands-on/laboratory activities at CQL", "I learned many new and interesting things during the day to day activities at CQL," and "I think about the new STEM information I learned in CQL when I am outside of the CQL site." These data are summarized in Actionable Evaluation and Appendix B.

Future STEM Engagement. Three items elicited apprentices' desire to pursue additional STEM activities after participating in the CQL program. Four other items relate their attitudes toward STEM and CQL to ways they may serve as role models to peers and to younger STEM learners. Apprentices responded to items on a 6-point scale of 1 = "Strongly disagree" to 6 = "Strongly agree." Summaries of these items are contained in Charts 11 and 12 below.

Chart 11: Apprentice - STEM Activities after CQL (n = 92)

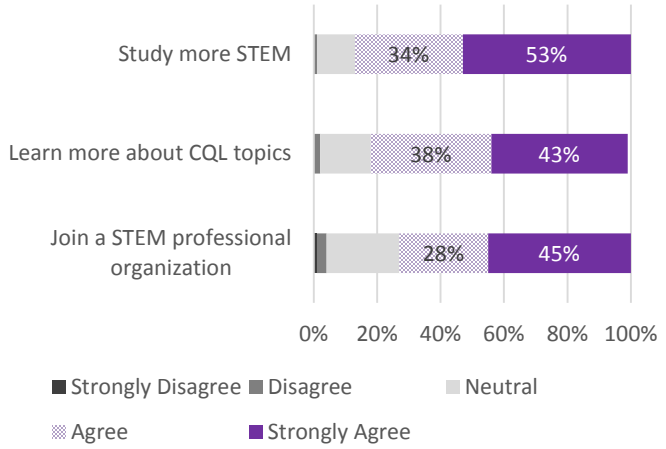


Chart 12: Apprentice - Role Model Activities after CQL (n = 92)

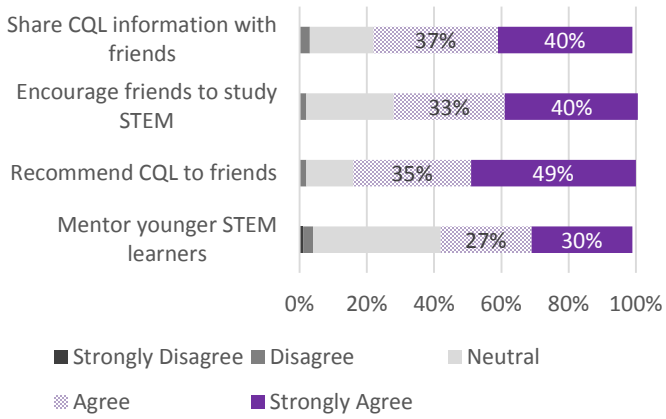


Chart 11 illustrates that apprentices are interested in pursuing STEM activities after participating in CQL. Most apprentices agree or strongly agree that they want to study more STEM after participating in CQL (87%), that they want to learn more about the STEM topics that they were exposed to during CQL (71%), and that they are interested in joining a STEM-related professional organization after CQL (73%). Although only 57% of CQL apprentices desired to mentor younger students (from Chart 12,) they like to share the information that they learned in CQL with their friends and family (77%) and will recommend CQL to their friends (84%). Fewer apprentices report that they will encourage their friends to study more STEM courses after CQL (73%).

Overall, the majority of apprentices intended to pursue STEM and STEM-based activities after participating in CQL, but also intend to serve as STEM role models and CQL ambassadors.

Army STEM

The Army's goal of establishing a coherent pipeline of opportunities for engaging and developing STEM talent from kindergarten to college, and then attracting that talent to Army/DoD careers, requires that each program promote its participants' awareness of both AEOP initiatives and Army/DoD STEM careers. Apprentices and mentors who are aware of the portfolio of AEOP programs can serve as stewards of AEOP in their personal and professional relationships, advancing the AEOP's mission of outreach. Mentors who are aware of and knowledgeable about the portfolio of AEOP programs can provide guidance and encouragement to apprentices regarding next steps in their AEOP pathway. Mentors

who are knowledgeable about Army/DoD STEM career opportunities can inspire apprentices' interest and appreciation of them and provide guidance about educational pathways to achieve them. Apprentices that have greater awareness of and positive attitudes toward Army/DoD STEM careers are more likely to seek them out in the future.

The assessments measured apprentice awareness and interest in participating in AEOP opportunities and Army/DoD STEM careers. In addition, the apprentice assessment measured apprentice attitudes toward Army/DoD STEM research and careers. Mentor assessments included corresponding items to corroborate apprentice findings and are shown here for comparison. These measures correspond to The following CQL Objectives:

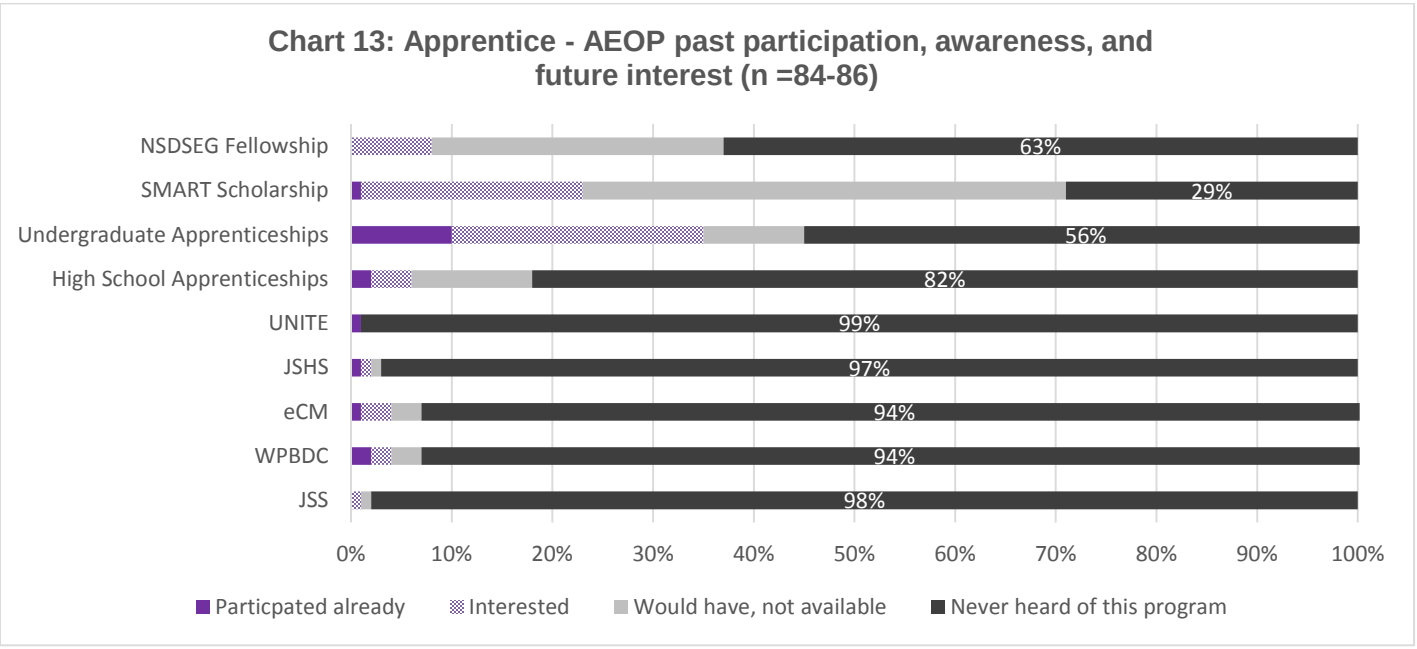
- Objective 5—To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories;
- Objective 6—To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community; and
- Objective 7—To provide information to participants about opportunities for STEM enrichment and ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.

AEOP Opportunities. Apprentice questionnaires simultaneously elicited past participation in, awareness of, and interest in other AEOP opportunities outside of the CQL sites. Item choices included "Participated already," "Want to Participate," "Would have participated but not available in my area," and "Have never heard about this program". These data are reported together in Chart 13 on the next page.

According to these items a very small proportion (1%-9%) of students had participated in any other AEOPs outside of the CQL site. A small proportion also expressed interest in participating in the program, presumably as a mentor. The most striking finding is that at the time of this questionnaire (near or after the conclusion of most CQL apprenticeships), many apprentices (up to 99%) indicated that they have never heard about various AEOP opportunities, that occur outside of the CQL site in which they worked

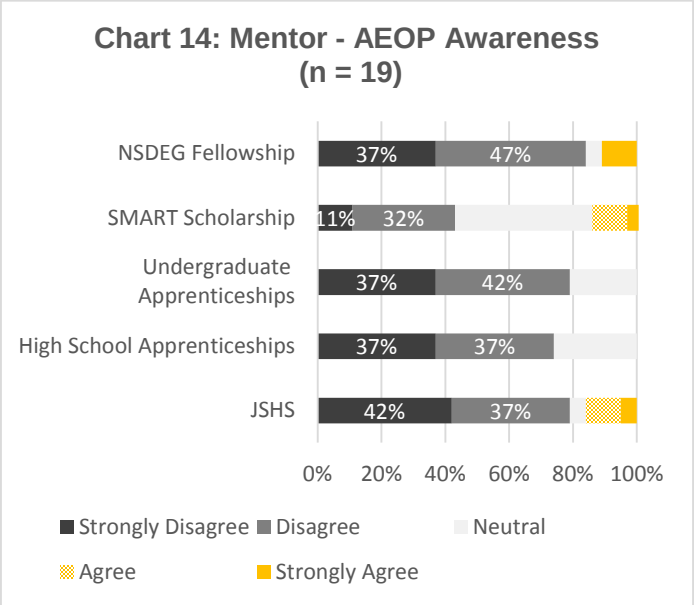
Army Educational Outreach Programs

- Junior Solar Sprint (JSS)
- Gains in Mathematics and Science Education (GEMS)
- West Point Bridge Design Competition (WPBDC)
- eCYBERMISSION (eCM)
- High School Apprenticeship Program (HSAP)
- Research and Engineering Apprenticeship Program (REAP)
- Science and Engineering Apprentices Program (SEAP)
- Undergraduate Research Apprenticeship Program (URAP)
- College Qualified Leaders (CQL)
- Science, Mathematics, & Research for Transformation (SMART) scholarship (Offered by DoD)
- National Defense Science and Engineering Graduate (NDSEG) (Offered by DoD)



Mentors were asked to report their level of awareness of AEOP and DoD opportunities, in part to assess the extent to which mentors are prepared to inform apprentices about future STEM engagement through AEOP or DoD programs, and how they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities. The items asked mentors to respond on a scale of 1 = "Strongly Disagree" (reflecting lack of awareness) to 6 = "Strongly Agree" (reflecting awareness) and are reported in Chart 14.

As shown in Chart 14, many mentors (43-84%) were generally unaware of various AEOP and DoD opportunities, especially those occurring outside of the CQL site. The majority of mentors were aware of undergraduate apprenticeships, such as the URAP program that occurs at ARO-sponsored universities nationwide. More than 50% were unfamiliar with other DoD scholarship/fellowship programs for attracting talented individuals to DoD research laboratories. When asked whether they provided information to their apprentices about AEOP and DoD educational programs, only 11% of mentors answered affirmatively with agree or strongly agree.



In summary, these data suggest that CQL sites and mentors have limited knowledge themselves and limited success in educating apprentices about AEOPs Apprentices are

generally unaware of opportunities for their own continued engagement in the AEOP pipeline, as well as opportunities to mentor other learners. This interest could be leveraged for targeted cross-promotion of programs by CQL mentors and/or and sites and to provide repeated engagement of apprentices in the AEOP pipeline.

Army/DoD STEM Careers. Items in the apprentice questionnaire measured the extent to which participants perceived learning about new STEM jobs and careers (herein called careers), and specifically, STEM careers within the Army/DoD. Subsequently, apprentices were asked whether they became interested in those new STEM careers. Chart 15 summarizes apprentices' perceptions of exposure to STEM and Army/DoD STEM careers during CQL, and resulting interest. Chart 16 summarizes mentors' perceptions of efforts to educate their apprentices about careers and apprentice interest in STEM careers. All items used a response scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree".

Chart 15: Apprentice - Awareness and Interest in STEM Careers (n = 87-88)

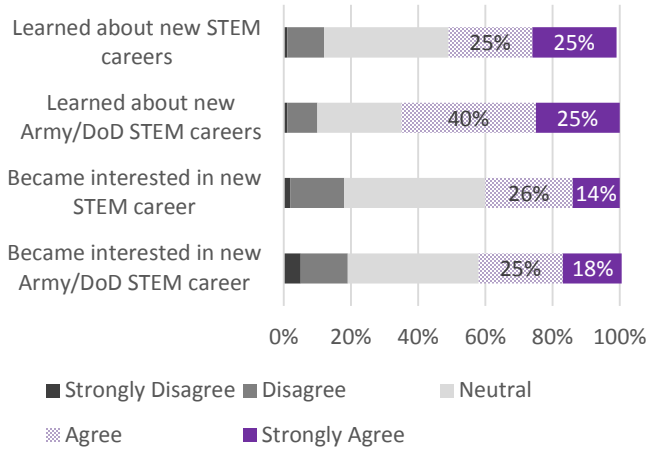
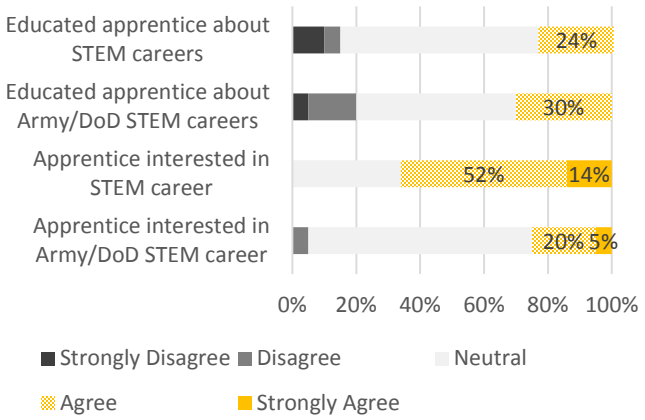


Chart 16: Mentor - Apprentice Awareness and Interest in STEM Careers (n = 20-21)



Charts 15 and 16 illustrate that a many apprentices had opportunities to and perceived learning about a wide variety of new STEM careers during CQL. Of 88 apprentices, 50% agreed that they learned about new STEM careers, while significantly fewer mentors (24%) reported educating apprentices about STEM careers.[16] The same pattern is visible with proportions of mentors and apprentices reports of opportunities to learn about Army/DoD STEM careers (75% apprentices, 30% mentors).[17] Two notable findings emerge from these data. First, significantly more apprentices reported learning about Army/DoD STEM careers than learning about new STEM careers in general, however, the difference is

[16] $p < 0.05$ with independent samples t-test (two tailed); STEM jobs, apprentices vs. mentors: Mean Diff = .73, $p = .020$, $d = .550$ moderate effect

[17] $p < 0.05$ with independent samples t-test (two tailed); Army/DoD STEM jobs, apprentices vs. mentors: Mean Diff = .94, $p = .000$, $d = .76$ moderate effect

considered small.[18] Second, moderately large, significant differences are found between apprentices perceptions related to learning about STEM and Army/DoD STEM careers, and mentors perceptions of educating apprentices about them.

Of the apprentice respondents, 40% reported becoming interested in a new STEM career during CQL, and 66% of mentors agreed that their apprentices expressed genuine interest in future STEM careers. A greater proportion of CQL apprentices (43%) reported becoming interested in Army/DoD STEM careers, though no significance difference exists when compared with interest in new STEM careers in general. A comparison of mentor items suggests a large significant difference in mentors' perceptions of apprentices' expressed interest to pursue Army/DoD STEM careers as opposed to STEM careers in general. Mentors perceived much lower expressions of apprentices' interest in Army/DoD STEM careers than in STEM careers in general.[19]

None of the above findings are inconsistent with data reported in previous sections. Apprentices have substantial exposure apprentices to Army/DoD STEM research and professionals in their daily work at CQL sites, and, receive considerable mentorship from those professionals. It is plausible that apprentices have other opportunities to and mechanisms for learning about new STEM and Army/DoD STEM careers beside direct contact with the Army S&E mentor. However, it is clear that CQL apprentices become interested in new careers (40%), and new Army/DoD STEM careers in particular (43%) through their apprenticeship. This potentially provides evidence for the power of apprenticeships hosted at Army research facilities to facilitate future interest in Army STEM careers, even when Army S&E mentors do not explicitly educate their apprentices about them.

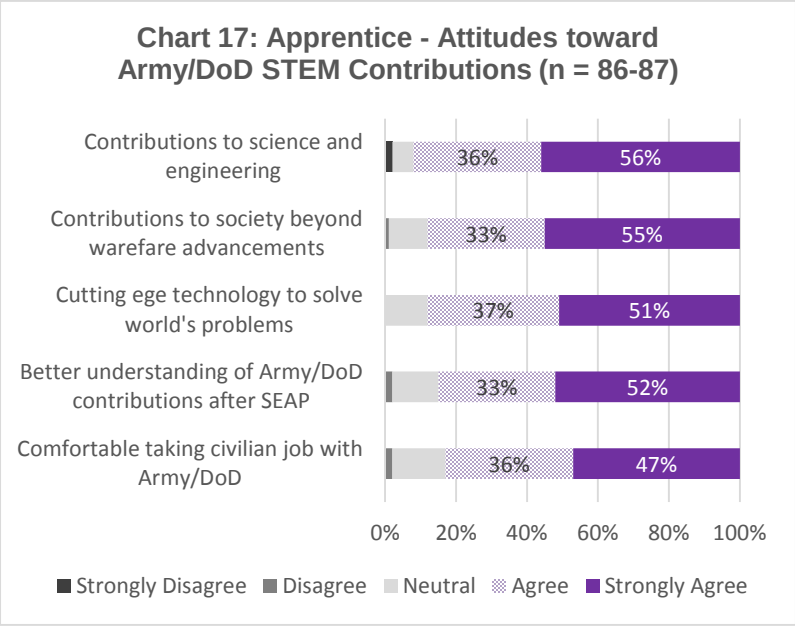
When asked which three new STEM jobs they found most interesting, 45 apprentices listed 102 different jobs or careers., summarized in Appendix B. Apprentices were interested in a range of research areas across one or more basic or applied fields of science (e.g., materials chemistry, biochemistry, neurophysics), technology (e.g., robotics, computer programming), engineering (e.g., materials, electrical, automotive design engineering, aeronautics or astronautics) and mathematics (e.g., signals processing), as well as medical/health sciences (e.g., audiology, epidemiology, forensic toxicology, medical practice) and social sciences (e.g., behavioral analysis). Apprentices listed a range of positions, such as technicians and analysts, researchers, technical writers, post-doctoral fellows, laboratory mangers, defense contractors, and STEM teachers and professors. Apprentices were interested in positions that potentially require application of STEM knowledge and skills in a government setting, including: analyst, chemist, and management for Forensic Exploitation Directorate (FXD), USACIL lobbyist, cost analyst for government programs, and M.D. Commander. Several apprentices expressed interest in completing professional degrees (i.e., Ph.D., M.D.) and then serving as an Army officer. One apprentice expressed interest in dismounted soldier group. From these few examples the reader can see that CQL apprentices were exposed to a wide range of different research, career fields, and positions requiring STEM competencies.

Overall, student and mentor accounts reveal that many apprentices (50%, according to apprentices) had opportunities to learn about (65%) and developed new interest in Army/DoD STEM careers (43%). Differences in apprentice and mentor accounts as observed here (and corroborated by focus group data reported previously in this report) suggest this exposure

[18] $p < .05$ with paired samples t-test (two tailed); Mean Diff = .239, t = 2.570, $p = .012$, $d = .274$ weak effect
[19] $p < .05$ with paired samples t-test (two tailed); Mean Diff= .800, t = 3.76, $p = .001$, $d = .841$, strong effect

to STEM and Army/DoD STEM careers came not only from their mentors, but potentially from other personnel in the apprentices' immediate laboratory or larger CQL site.

Attitudes toward Army/DoD STEM. Five items measured apprentices' attitudes toward Army STEM research and careers. Chart 17 summarizes apprentices' responses.



Most apprentices (83-92%) expressed agreement that Army research and researchers have made valuable contributions to science and engineering fields and to society. A majority of CQL apprentices (85%) credited CQL with improving their understandings of Army/DoD STEM contributions. In contrast to the 43% of apprentices who became interested in a job or career with the Army/DoD during CQL, 83% expressed they would be comfortable taking a civilian position in STEM with the Army/DoD. This difference suggests that CQL serves to inspire new interest and sustain existing interest in Army/DoD STEM careers. Subsequently, 62% of the 21 mentor respondents agreed or strongly agreed that their apprentices expressed a positive attitude toward the Army/DoD and STEM careers it offers.

CQL apprentice focus groups provide elaboration of these data. Of 34 apprentice interviewees, 27 suggested they would consider STEM jobs or careers with Army or other DoD agencies. Apprentices' reasons for considering careers in Army/DoD STEM included satisfaction with the work environment, resources, professional development opportunities, and available positions at the particular CQL site, as well as the positive impact of Army/DoD research to society and to soldiers. Of those that declared they were not interested in Army/DoD STEM positions, reasons included cumbersome processes and procedures with the Army, funding cuts and furloughs for researchers, and challenges with research collaborations.

We can conclude from apprentice data that CQL potentially impacted students' awareness of, attitude toward, and interest in Army STEM. Apprentice data suggests that CQL served to inspire interest in new STEM careers, including 43% expressing new interest in Army/DoD STEM careers. Since 83% would consider a civilian position in STEM with the Army/DoD, CQL likely also sustained pre-CQL interest in Army/DoD STEM careers. Furthermore, 85% of apprentices credited CQL with improving their understanding Army/DoD STEM contributions. Focus group data suggests that CQL provided apprentices with realistic snapshots of work at Army research labs, including both potential benefits and challenges of the work and work environment.

What Participants are Saying

An overwhelming majority of apprentices and mentors surveyed and interviewed spoke highly of their CQL experiences. Apprentices and mentors alike frequently encouraged expansion of CQL to address unmet local need and enhanced marketing for recruitment and greater public awareness of AEOP's role in STEM education. CQL apprentices frequently expressed gratitude for the positive ways in which CQL have prepared them for futures in STEM research. The following quotations provide illustration of overall participant satisfaction.

CQL contributes to Apprentice's educational and professional pursuits:

- "I am learning a lot of new skills and how to better contribute to the Army/DoD work environment in a meaningful way. The research being conducted has a lot of practical applications and having the ability to learn through the CQL program has helped me translate my own interests into a career path I did not consider prior to joining the program. Networking and being able to ask career questions of my mentors and peers gave me insight I would not have had the opportunity to ask otherwise.":
- "CQL gave me experience working in a professional engineering environment with high-quality lab equipment, as well as furthered my understanding of the research and technical writing process. These experiences will help me to increase my overall potential opportunities for employment, and have opened my eyes to additional career possibilities."
- "My experience with CQL has reinforced what I have learned in class at U o f I and taken it to the next level. I am much more confident with biology as a whole and really understand protocols rather than just following directions. This will be extremely useful as I finish my undergraduate degree and look ahead to medical school and beyond."
- "After my experience in CQL has sparked my interest to include research as part of my future career. Although I am uncertain whether my future career will include the department of defense, their contributions to society have made me want to pursue a meaningful career to help others. My current plan is to obtain an MD to practice medicine as well as conduct research."
- "CQL helped provide the resume content to get me considered at many high-level job opportunities and eventually get hired on by my employer of choice, performing my "dream job.""
- "CQL gave me the opportunity to do real life research in a real life laboratory… Being able to interact with scientists who are passionate about their work contributed greatly to my educational and professional experience. The guidance and leadership that (my mentor) and his team provided, lead to a positive learning experience. Their guidance and mentorship has allowed me to feel confident about working in STEM related research."

CQL Apprentices would participate again:

- "Most definitely! I gained so much knowledge about different fields while participating in this program. I feel like this definitely improved me as a person as well as a student, researcher, and future employee."
- "Yes. It was the most hands on experience I have had in a research lab. The opportunity is very unique - it not only taught me about science research, but also about the types of work that is done in the DoD."
- "Yes, of course I would want to participate in CQL again. This is the most rewarding program I have been a part of and I am lucky enough to be able to say I got the chance to be part of it."
- "Yes. I believe that this is a great way to get experience in the laboratory doing real research that will better our world one day. It helps me to put the concepts that I learn in my classes to work and to something worth-while."
- "Yes, this was hands down the best professional experience I have had thus far in my young professional life. It was a great glimpse into what a working lab and business entity looks like. I was treated as a member of the team which helped to instill confidence in my working ability and knowledge. I feel confident in my ability to pursue a career and catch on quickly to new ways of doing things."

CQL Apprentices value the experience:

- "The CQL research project I undertook was exactly what I had hoped to gain from the program: an example for how an engineering research job would play out for me. My most valuable takeaway from this experience is my knowledge of the overall process that I can utilize in problem-solving, and producing technical output, for future employers, as well as an increased overall self-confidence in my engineering skills."
- "Overall, I was very satisfied with my CQL research project/final presentation. I was very enthused to the fact that my research project was vital to the Latent Print community and I was able to write my first research paper to be published in the Journal of Forensic Identification. Lastly, my final presentation was in Washington, D.C. at the 65th Anniversary Meeting of the American Academy of Forensic Science. Awesome experience!"
- "The project was a very good learning experience in terms of leading and designing a research project, taking it from the earliest stages of conception to final conclusion, and presenting at the 2013 AAFS Conference in Washington DC. Obviously the presentation was one of the more valuable parts of the experience, since I believe it had a direct impact on my job prospects (I was offered 3 different jobs within a few months of the presentation), but I think the networking I made and continue to take advantage of was the most beneficial part. Those professional and personal relationships are invaluable to me and still contribute to my success today."
- "I very much enjoyed my internship at USACIL. I became an "expert" in a specific topic, and was able to present my findings to other colleagues and scientists in the field. I believe the most valuable experience was being able to work under the same conditions as they are overseas and to collaborate with the DNA and latent print analysts."

CQL Mentors value their apprentice's contributions:

- "I was impressed with what [he] accomplished. Due to scheduling, he often had to work independently without immediate supervision. That did not prevent him from working through project."
- "[He] went way above my expectations and proved to be a great asset to our research project."
- "[Her] novel work warrants publication in a peer-reviewed journal. It will advance testing methods for the field."
- "He has been an excellent apprentice - smart, capable, inventive, can work independently, and eager to achieve and produce results. I highly recommend him for future internships or even a position after he graduates."
- "[She] is a true pleasure to work with and her sense of integrity, duty, and commitment demonstrate maturity well beyond her age."
- "Programmatically... My apprentices experienced greater than expected delay in being able to access their computers ... One of my apprentices was able to recover from a severe delay in having a specific software installed on their computer. This apprentice took the initiative to approach the problem a different way, resulting in their greater understanding of the problem and its accompanying theory."
- "As a sophomore-to -be, [he] has been very successful in implementing the algorithms we suggested for his project. He has taken a lot of initiative to look up and study facial recognition algorithm. ARL's IT policies made this difficult – [he] was able to work around it."
- "[He] was well trained, understood the research process and the tools needed to complete the project. He worked well with others and provided some training to existing employees in some of the techniques. I would have hired him full time if I could."

Summary of Findings

The 2013 evaluation of UNITE collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 16.

Table 16. 2013 CQL Evaluation Findings	
Participant Profiles	
All evaluation data contribute to the overall narrative of CQL's efforts and impact, and highlight areas for future exploration in programming and evaluation. However, confidence in evaluation findings varies by participant group.	• Statistical reliability calculated for the apprentice questionnaire (margin of error = ±8.1% at 95% confidence level) and alternative methods for establishing representativeness (statistical comparison of apprentice respondents' and participants' demographic information revealed no significant differences) suggest findings from the apprentice questionnaire may be sufficiently generalizable to the apprentice population.
	• Statistical reliability calculated for the mentor questionnaire (margin of error = ±20% at 95% confidence level) and lack of available demographic information with which to make alternative determinations suggest mentor respondents may not be representative of the mentor population. Mentors contribute valuable perspective to CQL evaluation and any findings from mentor questionnaires should be cautiously generalized with consideration given to the margin of error and with triangulation of findings with other data.
CQL had some success in providing outreach to participants from historically underrepresented and underserved populations.	• Apprentices included female students (35%)—a population that is historically underrepresented in some STEM fields.
	• Apprentices identified as Black or African American (9%) and Hispanic or Latino (5%), and American Indian or Alaskan Native (1%)—these populations are among those historically considered underserved and underrepresented in STEM education.
	• Mentors identified as predominantly male (67%) and White or Caucasian (57%). Of the 22 mentor respondents, 15% identified as Black or African American (10%) and Hispanic or Latino (5%).
CQL serves the Nation's future STEM workforce.	• Most CQL apprentices are pursuing STEM degrees. 95% of apprentices planned to pursue a degree in a STEM field (10% Bachelors, 33% Master's, 52% Doctorate.)
	• Most CQL apprentices intend to pursue STEM careers. Most frequently, apprentices reported currently working on engineering degree (48%) and similar intent to pursue an engineering career (48%). Medicine/health was the second most frequent career field listed (17%). Apprentices also intended to pursue careers in life science (9%), chemistry (7%), physical science (6%) and math/computer science (3%), as well as other STEM (6%) and non-STEM (2%) fields.
Actionable Program Evaluation	
CQL marketing and recruitment was largely a site-based endeavor.	• CQL sites marketed CQL to local universities and educators, as well as to participants of other AEOP programs at the site.
	• More than one third of apprentice interviewees reported learning about CQL through friends, family, family friends, or university professors with connections to CQL site, program, or mentor. Similarly, 37% of apprentice questionnaire respondents reported having a family member or family friend at the Army research facility where the CQL apprenticeship took place.

	• More than one third of apprentice interviewees learned of CQL through GEMS, SEAP, or Near Peers programs at the site. Questionnaire respondents reported past participation in GEMS (10%), SEAP (24%), and Near Peers (3%).
	• Many mentors reported selecting apprentices that had been "vetted" by a personal or professional connection of the mentor.
CQL apprentices desired repeated engagement at Army labs and opportunities to advance their STEM pathways.	• Apprentices were motivated to participate in CQL by their desire for repeated engagement at the Army labs after participating in CQL or other AEOPs at the site (e.g., GEMS, SEAP, or Near Peers) Apprentices also participate because they generally wish to advance their STEM pathways: build research skills, gain research experience, apply school learning, and their build applications or resumes.
CQL mentors sought opportunities to engage with STEM learners in their work.	• Mentors chose to participate in CQL because of positive experiences as CQL, SEAP, or GEMS mentors, for opportunities to re-engage former apprentices in the research project, and to have project needs met by hosting an apprentice.
CQL mentors used a team-based approach to engaging their apprentices in STEM research and supporting their educational and career pathways.	• Apprentices and mentors questionnaire respondents reported similar frequencies of mentor activities related to engaging apprentices in STEM research. Similarly, apprentice and mentor interviewees frequently reported activities reviewing apprentice work and giving feedback; grounding laboratory work in scientific principles and practices; and training the apprentice to perform laboratory tasks and procedures.
	• Moderately large to very large significant differences were found in apprentices' and mentors' perceptions support for educational and career pathways. Other laboratory personnel contributing to the day-to-day mentoring of apprentices may provide other mechanisms for support of educational and career pathways beyond that provided by Army S&Es.
CQL mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers.	• Most mentor interviewees had limited awareness of AEOP initiatives. Subsequently, mentors did not consistently educate their apprentices about AEOPs or encourage apprentices to participate in them.
	• Mentors suggested that informational resources provided to mentors or apprentices, mentor training, and clear expectations for promoting other AEOPS were necessary to accomplish this objective.
	• Mentors reported a variety of strategies for mentoring apprentices about STEM careers, with a strong emphasis on Army/DoD STEM careers. Some mentors suggested that the experience itself educated apprentices about STEM research and careers with the Army.
	• Mentors perceived that furloughs, their own lack of awareness, and lack of resources for educating about STEM careers were challenges to providing career mentorship. Mentors requested resources to share with apprentices and suggested a number of programmatic changes that would increase the visibility of Army/DoD STEM professionals in CQL.
CQL benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that CQL benefits apprentices by providing authentic research opportunities not typically available in school settings, opportunities to expand their STEM competencies and confidence in those competencies, and opportunities to advance their STEM pathway, and access to effective mentorship.
	• Mentors also perceived benefits to their laboratories and to themselves. Most notably, mentors indicated that apprentices are low-cost yet highly effective members of the lab, and

	apprentices have made meaningful contributions to research with near-term impact on Army processes or procedures.
CQL's administrative processes and mentee-mentor matching are possible areas for improvement.	• Apprentices and mentors perceived challenges with the "cumbersome" and "time-consuming" administrative tasks associated with the CQL, suggesting they detract from work that can be accomplished during an already short (and furlough-disrupted) summer apprenticeship. Mentors perceived low organization of and support for these tasks.
	• Apprentices suggested processes for mentee-mentor matching could be improved to ensure apprentices have sufficient work to do and can contribute beyond a singular task or procedure. One apprentice suggested professional development is needed for mentors.
Outcomes Evaluation	
CQL engaged apprentices in authentic STEM activities more frequently than their school environment.	• Apprentices reported that CQL provided more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (35%-69% in CQL, 16%-46% in school) and hands-on research activities (29%-71% in CQL, 16%-39% at school). Small to moderately large, significant differences were found for 9 of 12 STEM activities.
	• Apprentice and mentor data suggested CQL had a slightly larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
CQL apprentices became more confident in STEM, and mentors rated their research and reporting skills highly.	• A majority of apprentices (68%-85%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (53%-91%) rated their apprentices at near expert or expert levels of the development continuum across 6 key STEM skills and abilities: information literacy, scientific reasoning, laboratory, data collection, quantitative literacy, and teamwork and collaboration. Most mentors (92-100%) also rated all 6 components of their apprentices' final research project or presentation as near expert or expert level.
CQL apprentices intended to pursue more STEM activities, including serving as STEM role models.	• 73-87% of CQL apprentices intend to pursue STEM activities after participating in CQL, including studying more STEM, learning more about topics they learned about in CQL, and joining professional organizations.
	• 57-84% of CQL apprentices intend to serve as a role models by sharing their CQL experiences with friends, recommending CQL to friends, encouraging friends to study more STEM, and mentoring younger STEM learners.
CQL apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Many apprentices (29-99%) and mentors (43-84%) were unaware of other AEOP initiatives, with higher proportions lacking awareness for programs occurring outside of the CQL site.
	• CQL apprentices are interested in participating in other AEOP opportunities: college apprenticeships (25%), college scholarship programs (22%), and graduate fellowships (8%) offered by AEOP or DoD. This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
	• A small proportion of CQL apprentices (1%-4%) expressed interest in middle and high school programs, presumably as mentors or other volunteers.

CQL improves and sustains apprentices' positive attitudes toward the defense community and their interest in potential government service.	• Many apprentices had opportunities to learn about new STEM careers during CQL as reported by apprentices and mentors (50% apprentices, 24% mentors). Army/DoD STEM careers received substantial attention (75% apprentices, 30% mentors). Apprentices clearly have other opportunities to and mechanisms for learning about new STEM and Army/DoD STEM careers beside direct contact with the mentor.
	• CQL served to inspire interest in new STEM careers, with 43% of apprentices expressing new interest in Army/DoD STEM careers in particular. Since 83% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society, suggesting that CQL also sustains existing interest in Army/DoD careers.
	• Most apprentices (85%) credited CQL with improving their understanding Army/DoD STEM contributions. Most mentors (62%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Coordinated efforts should be made by the Army, ASEE managers, and site coordinators to encourage and improve apprentice and mentor participation in the CQL evaluation efforts. The low response rates to evaluation assessments pose the most significant threat to the validity of findings from those assessments, and, furthermore, prevent any reliable comparisons from those data from year to year. While evaluators can assess representativeness of samples through alternative means, accurate demographic data must be available for the population in order to accomplish these determinations. With respect to the outcomes evaluation, mentors' assessment of apprentice performance are important for triangulating apprentices' perceptions of growing confidence in their STEM competencies. Future evaluation will continue to rely on mentors to provide an authoritative, albeit subjective, assessment of apprentices' performance and *growth* in apprentices' STEM competencies. Mentors reported awareness of and efforts to promote AEOP and Army STEM are important for understanding related apprentice outcomes and identifying site-level programming needs (e.g., resources and/or training for mentors). Evaluators will endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments; however, evaluators necessarily rely on the assistance of Army, ASEE managers, and site coordinators to promote a culture of evaluation among both CQL apprentices and mentors.

2. The number of applications for CQL apprenticeships (588 applications for 260 funded apprenticeships) is indicative of unmet need. Of particular note, rate of participation varied from 0% to 53% at CQL sites having greater than 19 applicants. To the extent allowed by annual budget constraints, CQL should endeavor to engage more Army S&E mentors, thereby creating more apprenticeship positions to populate. CQL programming may benefit from a careful examination of and attention to program- and site-level structures, processes, and resources that both enable and discourage Army S&Es' participation in CQL. Program- and site-level accommodations may be required to further improve Army S&Es' awareness of CQL, feasibility of their participation, and overall motivation to participate in CQL. Mentors noted multiple challenges that they or their apprentices encountered that, if eliminated could provide greater retention of existing mentors and increased recruitment of new mentors. Simultaneous with this effort, ASEE and CQL sites might consider how to effectively recruit a more demographically diverse mentor pool to provide apprentices with greater access to same-demographic role models and mentors.

3. CQL and AEOP objectives include the inclusion and expansion of students from historically underrepresented and underserved populations in programs. While ASEE and local sites conduct targeted marketing of CQL to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in determining CQL apprentices. CQL may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide, including but not limited to 1) maximizing the recruitment and repeated engagement of female, racial/ethnic minorities, and low income students in GEMS and SEAP programming (where available), 2) subsequent recruitment of those alumni as CQL apprentices, and 3) recruiting new students into the pipeline from historically black colleges and universities and other minority serving institutions. Guidance may also be provided to ensure other "connected"

applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and CQL sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site).

4. ASEE, CQL sites, and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encourage continued participation in programs for which apprentices qualify. Evaluation data suggests that CQL apprentices and mentors were largely unaware of other AEOP initiatives, especially those offered outside of the Army research facilities. Yet, apprentices showed interest in university-based apprenticeships and undergraduate scholarships, as well as in AEOPs offered to younger STEM learners (presumably interested in serving as mentors). This interest would benefit from more robust attention by site coordinators and mentors during CQL program activities. Continued guidance by ASEE is needed for educating CQL site coordinators and mentors about AEOP opportunities, especially beyond the CQL sites. Adequate resources and guidance for using them with apprentices should be provided to all site coordinators and mentors in order that all apprentices leave CQL with an idea of their next steps in AEOP, whether at or outside of the Army site.

5. Most apprentices had opportunities to learn about STEM research and careers during CQL, especially Army/DoD STEM research and careers to which they are exposed daily. However, many mentors reported lack of awareness of STEM careers beyond their own, lack of informational resources, and lack of time for not educating apprentices about other STEM careers. Evaluation findings also suggest that other laboratory personnel contribute substantially to the mentorship of apprentices, and may be providing more support for educational and career pathways than the mentor. Thus, they would benefit from the same supports requested by mentors. We strongly recommend a CQL- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[20]

[20] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

Appendices

Appendix A:
2013 CQL Evaluation Plan

Key Evaluation Questions

The CQL evaluation gathered information from apprentice and mentor participants about CQL processes, resources, activities and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and CQL program objectives:

- What aspects of CQL motivate participation?
- What aspects of CQL structure and processes are working well?
- What aspects of CQL could be improved?
- Did participation in CQL:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

Methods and Instruments

The FY2013 evaluation used a mixed methods approach[1] to allow for broad generalization and for deeper focusing of the evaluation. This mixed methods approach employed quantitative measures to assess level of agreement or satisfaction, as well as qualitative measures, such as open or constructed-response items in questionnaires and focus groups that provided less structured items assessing perceived value, satisfaction, or suggestions for improvement.

The assessment strategy for CQL included onsite focus groups with apprentices and mentors at 4 CQL sites, a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubrics.

Data Collection and Sampling

Evaluators collected data from 2013 summer programs during a six week period from early July through mid-August, and, when possible, toward the conclusion of a site's summer activities. Focus groups were conducted at 4 CQL sites in the Eastern, U.S. Mentor focus groups included 20 Army S&E mentors for SEAP and/or CQL (10 females, 10 males). SEAP and CQL mentors were interviewed together (as they often worked with both programs), but herein they will be referred to as CQL mentors. Apprentice focus groups included 33 apprentices (19 females, 15 males). While evaluators provided program staff with guidelines for purposive sampling when assembling focus groups where large numbers of students were available (e.g., equal representation of males and females and a range of age/grade levels, race/ethnicity demographics, and STEM interests), convenience sampling was ultimately employed for both apprentice and mentor focus group at each site.

Evaluators administered online questionnaires to apprentice and mentor participants during a 10-day period in late July and early August (more than halfway through the apprenticeship) to accommodate a review of data in support of FY14 planning. The questionnaires continued to collect data beyond that period, in an order to allow mentors to complete rubrics for their apprentices' final project and presentation. Few mentors did so. Questionnaires also employed convenience sampling. All apprentices

[1] Creswell, 2003; Quinn 2001; Greene & Caracelli, 1997

and mentors were invited to participate in these questionnaires, which were emailed to them by the CQL program administrator and/or CQL site coordinator. Mentors were also sent links for the apprentice questionnaire to further encourage apprentice participation. Questionnaires consisted of closed or forced-response "quantitative" items as well as opened or constructed-response "qualitative" items.

Data Analyses

Quantitative and qualitative data were compiled and analyzed after all data collection concluded.

Evaluators summarized quantitative data with descriptive statistics such as numbers of respondents, frequencies and proportions of responses, average response when responses categories are assigned to a 6-point scale (e.g., 1 = "Strongly Disagree" to 6 = "Strongly Agree"), and standard deviations. All apprentice and mentor data collected from questionnaires are summarized fully in Appendices B and C.

Charts used within this report narrative provide visual representations of data in terms of proportions of responses, unless otherwise noted. This allows the reviewer to easily apply the determined margin of error for each participant groups' questionnaire responses. For visual simplicity of charts, "Somewhat Disagree" and "Somewhat Agree" (and similar categories) are aggregated as "Neutral" responses.

Evaluators conducted inferential statistics (herein called comparison or significance testing[2]) on key items to compare effect of CQL and school experience and/or to compare participant group perceptions, ultimately to identify statistically and practically significant differences in these data. Statistical significance indicates whether a result is different than chance alone. Statistical significance is determined with t-, McNemar, ANOVA, or Tukey's tests, with significance defined at $p < 0.05$. Practical significance, also known as effect size, indicates how weak or strong (also noted as small or large) an effect is and is usually studied in relation to statistical significance. Practical significance is determined with Cohen's *d* or Pearson's *r*, with *d* or *r* of .250, which is considered weak but "substantively important" at $p < 0.05$.[3] Statistically and/or practically significant findings are noted as "statistical" or "significant" in the report narrative with footnotes or tables providing details and results of statistical tests. These findings should be taken as potential indicators of effect and potentially promising activities for sites to explore in more depth; they should not be taken as a rigorous measure of the effectiveness of any one sites' structures, processes, or activities.

Evaluators analyzed qualitative data, including constructed-response questionnaire and focus group data for emergent themes. These data are then summarized by theme, by frequency of participants addressing a theme, and sample participant responses for that theme. When possible, two raters analyze each complete qualitative data set. When not possible, a portion of the data set are analyzed by both raters to

[2] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

[3] U.S. Department of Education, What Work's Clearinghouse Procedures and Standards Handbook, accessed June 30 http://ies.ed.gov/ncee/wwc/pdf/reference_resources/wwc_procedures_v3_0_draft_standards_handbook.pdf

determine and ensure inter-rater reliability. Thus, the summary of themes and frequency for constructed-response questionnaire items generally represent evaluators' consensus ratings.

To the extent possible, findings were triangulated across data sources (apprentices, mentors), data types (quantitative questionnaire data and qualitative data from questionnaires and focus groups), and different evaluators conducting the analyses and reporting. This triangulation enhances the credibility of findings synthesized from single data sources or data types. For example, evaluators identify trends from the qualitative data—emergent themes with high frequencies in respondents addressing them—to provide additional evidence of, explanation for, or illustrations of quantitative data. We have posed plausible explanations when divergence between data sources or data types is evident; any such explanations are worthy of further exploration in the full study and, potentially, in future evaluation efforts. Periodically, less unique perspectives are reported and identified as such when they provide illustration that captures the spirit of CQL or AEOP objectives.

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

2013 College Qualified Leaders: Apprentice Questionnaire

Thank you for your participation in this study about the 2013 College Qualified Leaders (CQL) Program. The following assessment will collect information about you and your CQL apprentice(s). The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support CQL.

About this survey:

- This research protocol has been approved for use with human subjects by the Virginia Tech IRB office. Although this assessment is not anonymous, it is CONFIDENTIAL; prior to analysis and reporting, responses will be de-identified and no one will be able to connect your responses to you or your apprentice's name.
- Additionally, only AEOP evaluation personnel will have access to completed assessments and personal information will be stored securely.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time.
- If you provide your email address, the AEOP may contact you in the future to ask about you or your CQL apprentice(s).
- We do hope that you will finish the survey because your responses will give CQL valuable information for improvement and for generating reports for our supporting organizations

By choosing to completed this assessment, you are providing your consent to participate in the CQL research/evaluation study

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Tim Donovan, American Society for Engineering Education
Project Assistant, CQL
(202) 649-3833, T.Donovan@asee.org

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Provide your personal information below (optional):

First Name: _____

Last Name: _____

Email Address: _____

Age (in years): _____.

What is the duration of your 2013 CQL apprenticeship?

- ❍ It is a SUMMER apprenticeship
- ❍ It is a 6-MONTH apprenticeship
- ❍ It is a 9-MONTH apprenticeship
- ❍ It is a 12-MONTH apprenticeship
- ❍ Other (specify): _____

Who is your CQL mentor?

Your mentor's first name: _____

Your mentor's last name: _____

Did you participate in GEMS as a student?

- ❍ No
- ❍ Yes: How many times? _____

Have you previously worked as a SEAP apprentice?

- ❍ No
- ❍ Yes: How many times? _____

Have you previously worked as a "near-peer" mentor for GEMS?

- ❍ No
- ❍ Yes: How many times? _____

Have you previously worked as a CQL apprentice?

- ❍ No
- ❍ Yes: How many times? At which Army installation(s)? _____

In which laboratory are you working? (select from the list)

- ❍ AMRDEC; Redstone Arsenal, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ECBC; Edgewood, MD
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ NATICK; Natick, MA
- ❍ USACEHR; Fort Detrick, MD
- ❍ USACIL; Fort Gillem, GA
- ❍ USAMRICD; Aberdeen, MD
- ❍ USAMRIID; Fort Detrick, MD
- ❍ Walter Reed (WRAIR); Silver Spring, MD
- ❍ Other (specify): _____

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Prior to becoming a CQL apprentice, did you already know someone who works at your laboratory site?

- ❍ Yes - a family member that works at this lab site
- ❍ Yes - a family friend that works at this lab site
- ❍ No - I did not know anyone that works at this lab site

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your ethnicity/race?

- ❍ American Indian or Alaska Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White or Caucasian
- ❍ Some other ethnicity/race: _____
- ❍ Choose not to report

What degree are you currently pursuing?

- ❍ Bachelor's
- ❍ Master's
- ❍ Doctor of Philosophy (e.g., Ph.D.)
- ❍ Medical Doctorate (e.g., M.D. or D.O.)
- ❍ I'm a Post Baccalaureate or Post Graduate
- ❍ Other (please specify): _____

Which of the following categories best describes the STEM field you are currently pursuing?

- ❍ Engineering (e.g., technology, robotics, computers, etc.)
- ❍ Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)
- ❍ Physical Science (e.g., physics, astronomy, etc.)
- ❍ Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)
- ❍ Life Science (e.g., biology, animal science, ecology, etc.)
- ❍ Medicine / Health (e.g., behavioral science, medicine, public health, etc.)
- ❍ Mathematics / Computer Science
- ❍ Social Science (e.g., sociology, psychology, economics, etc.)
- ❍ Other STEM field: _____

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to think about the Science, Technology, Engineering, and Math (STEM) activities that you have participated in during your CQL experience. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I want to study more Science, Technology, Engineering, or Math (STEM) after participating in CQL	❍	❍	❍	❍	❍	❍
I enjoyed the hands-on / laboratory work during CQL	❍	❍	❍	❍	❍	❍
I learned many new and interesting things during the day-to-day activities in CQL	❍	❍	❍	❍	❍	❍
I like to share the information that I learned in CQL with my peers, friends, and family	❍	❍	❍	❍	❍	❍
I think about the new STEM information I learned in CQL when I am outside of the laboratory	❍	❍	❍	❍	❍	❍
After CQL, I intend to join a STEM-related professional organization	❍	❍	❍	❍	❍	❍
I want learn more about the STEM topics that I was exposed to during CQL	❍	❍	❍	❍	❍	❍
After CQL, I will encourage my peers to study more STEM courses	❍	❍	❍	❍	❍	❍
I will recommend CQL to my friends	❍	❍	❍	❍	❍	❍
After CQL, I want to mentor younger students in learning about STEM	❍	❍	❍	❍	❍	❍

Please take a moment to think about your CQL MENTOR. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
My CQL mentor frequently worked with me in the laboratory	❍	❍	❍	❍	❍	❍
I learned a lot from my CQL mentor about performing STEM research	❍	❍	❍	❍	❍	❍
My CQL mentor encouraged me to perform a variety of tasks in the laboratory	❍	❍	❍	❍	❍	❍
My CQL mentor helped me to formulate my educational goals	❍	❍	❍	❍	❍	❍
My CQL mentor taught me how to work more effectively in a laboratory	❍	❍	❍	❍	❍	❍
MY CQL mentor spoke with me about my career interests	❍	❍	❍	❍	❍	❍
My CQL mentor helped me become a better writer of scientific research	❍	❍	❍	❍	❍	❍
I would like to work with my CQL mentor again	❍	❍	❍	❍	❍	❍

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
My CQL mentor helped me clarify my pathways to achieve my academic goals	❍	❍	❍	❍	❍	❍
My CQL mentor gave me advice about the steps I need to take to achieve my professional goals	❍	❍	❍	❍	❍	❍
My CQL mentor helped me with my CV/Résumé	❍	❍	❍	❍	❍	❍
My CQL mentor will write or help me obtain letters of reference	❍	❍	❍	❍	❍	❍
My CQL mentor taught me about professional and educational networks that will help me in the future	❍	❍	❍	❍	❍	❍
My CQL mentor exposed me to professional organizations that can help me with my career/educational goals	❍	❍	❍	❍	❍	❍
I would recommend my CQL mentor to other students	❍	❍	❍	❍	❍	❍

Please take a moment to consider your UNDERGRADUATE or GRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In school, I had to define a research question or thesis and determine its critical concepts	❍	❍	❍	❍	❍	❍
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	❍	❍	❍	❍	❍	❍
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	❍	❍	❍	❍	❍	❍
In school, I had to organize and synthesize information across academic sources	❍	❍	❍	❍	❍	❍
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	❍	❍	❍	❍	❍	❍
In school, I had to work as part of a team on research projects	❍	❍	❍	❍	❍	❍

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to consider your CQL research experiences. Use the scale provided to indicate how often you performed each of the following activities IN CQL:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In CQL, I had to define a research question or thesis and determine its critical concepts	❍	❍	❍	❍	❍	❍
In CQL, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	❍	❍	❍	❍	❍	❍
In CQL, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	❍	❍	❍	❍	❍	❍
In CQL, I had to organize and synthesize information across academic sources	❍	❍	❍	❍	❍	❍
In CQL, I had to determine appropriate ethical and legal uses of published academic research for my own work	❍	❍	❍	❍	❍	❍
In CQL, I had to work as part of a team on research projects	❍	❍	❍	❍	❍	❍

Please take a moment to consider your UNDERGRADUATE or GRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In school, I used advanced science or engineering equipment	❍	❍	❍	❍	❍	❍
In school, I cleaned and cared for the equipment in a science or engineering laboratory	❍	❍	❍	❍	❍	❍
In school, I calibrated laboratory equipment for experimentation	❍	❍	❍	❍	❍	❍
In school, I created solutions from reagents in preparation for experimental procedures	❍	❍	❍	❍	❍	❍
In school, I used proper safety procedures when handling equipment and material in the lab	❍	❍	❍	❍	❍	❍
In school, I employed advanced measurement techniques in science or engineering procedures	❍	❍	❍	❍	❍	❍

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to consider your CQL research experiences. Use the scale provided to indicate how often you performed each of the following activities DURING CQL:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In CQL, I used advanced science or engineering equipment	❍	❍	❍	❍	❍	❍
In CQL, I cleaned and cared for the equipment in a science or engineering laboratory	❍	❍	❍	❍	❍	❍
In CQL, I calibrated laboratory equipment for experimentation	❍	❍	❍	❍	❍	❍
In CQL, I created solutions from reagents in preparation for experimental procedures	❍	❍	❍	❍	❍	❍
In CQL, I used proper safety procedures when handling equipment and material in the lab	❍	❍	❍	❍	❍	❍
In CQL, I employed advanced measurement techniques in science or engineering procedures	❍	❍	❍	❍	❍	❍

Use the scale provided to tell us how accurately each statement describes you AFTER CQL:

	Not at all like me	Not like me	Not much like me	Somewhat like me	Like me	Just like me
After CQL, I am more confident in my ability to formulate hypotheses and design experiments to test them	❍	❍	❍	❍	❍	❍
After CQL, I am more confident that I can analyze data and understand the results of an experiment	❍	❍	❍	❍	❍	❍
After CQL, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	❍	❍	❍	❍	❍	❍
After CQL, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	❍	❍	❍	❍	❍	❍
After CQL, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	❍	❍	❍	❍	❍	❍
After CQL, I am more confident in my ability to complete academic literature reviews for my own research projects	❍	❍	❍	❍	❍	❍
After CQL, I am more confident that I can make significant research contributions as an effective part of a research team	❍	❍	❍	❍	❍	❍

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?

- ❍ 2-year/Associate's degree in a science, technology, engineering and/or mathematics (STEM) related field
- ❍ 2-year/Associate's degree in something other than a STEM-related field
- ❍ Bachelor's degree in a STEM-related field
- ❍ Bachelor's degree in something other than a STEM-related field
- ❍ Master's degree in a STEM-related field
- ❍ Master's degree in something other than a STEM-related field
- ❍ Doctoral degree in a STEM-related field
- ❍ Doctoral degree in something other than a STEM-related field

Consider the highest level of education that you plan to pursue (your response to the question above). Using the scale provided, please tell us how certain you are that you will be able to do each of the following?

	Not at all Certain	Uncertain	Relatively Uncertain	Relatively Certain	Certain	Very Certain
I will be admitted into my program of choice	❍	❍	❍	❍	❍	❍
I will attend college to pursue this educational degree	❍	❍	❍	❍	❍	❍
I will get good grades in my classes	❍	❍	❍	❍	❍	❍
I will be able to overcome any obstacle between me and this educational degree	❍	❍	❍	❍	❍	❍
I will finish this degree	❍	❍	❍	❍	❍	❍

Use the scale provided to tell us how certain you are that you will do each of the following activities in the future?

	Not at all Certain	Uncertain	Relatively Uncertain	Relatively Certain	Certain	Very Certain
I will apply for jobs in a STEM-related field	❍	❍	❍	❍	❍	❍
I will get a job in a STEM field	❍	❍	❍	❍	❍	❍
I will build a career around my STEM skills	❍	❍	❍	❍	❍	❍
I will pursue STEM jobs with the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
I will build a STEM career with the Army/DoD	❍	❍	❍	❍	❍	❍

Which of the following categories best describes the STEM field that you want to build your career around?

- ❍ Engineering (e.g., technology, robotics, computers, etc.)
- ❍ Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)
- ❍ Physical Science (e.g., physics, astronomy, etc.)
- ❍ Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)
- ❍ Life Science (e.g., biology, animal science, ecology, etc.)
- ❍ Medicine / Health (e.g., behavioral science, medicine, public health, etc.)
- ❍ Mathematics / Computer Science
- ❍ Social Science (e.g., sociology, psychology, economics, etc.)
- ❍ Other STEM field
- ❍ A field unrelated to STEM

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
In CQL, I learned about new STEM-related jobs/careers.	❍	❍	❍	❍	❍	❍
In CQL, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
In CQL, I became interested in a STEM job/career I did not know about before.	❍	❍	❍	❍	❍	❍
In CQL, I became interested in a new STEM-related job/career with the Army/DoD	❍	❍	❍	❍	❍	❍

Of the new STEM jobs/careers that you learned about, which three did you find MOST INTERESTING? (Please list them):

Job #1:

Job #2:

Job #3:

Use the scale provided to tell us how much you agree or disagree with the following statements about the Department of Defense (DoD):

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
The Army/DoD has made many important contributions to science and engineering with applied research	❍	❍	❍	❍	❍	❍
Army/DoD researchers contribute much more to society than just "warfare" advancements	❍	❍	❍	❍	❍	❍
Army/DoD researchers use cutting-edge technology to solve the world's problems	❍	❍	❍	❍	❍	❍
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	❍	❍	❍	❍	❍	❍
After CQL, I have a better understanding of the important contributions that Army/DoD researchers have made every day civilian life	❍	❍	❍	❍	❍	❍

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Have you ever participated in/heard about any of the following programs?

	Yes, I participated	I would have participated but it was not available in my area / I did not qualify for this program	I am interested in participating in this program	I have never heard about this program
Junior Solar Sprint (JSS): A solar-car building and race for 6th – 8th grade	❍	❍	❍	❍
Junior Science and Humanities Symposium (JSHS): A high school STEM research competition	❍	❍	❍	❍
UNITE: An engineering summer program for high school students from underserved groups	❍	❍	❍	❍
West Point Bridge Contest: A computer-based engineering design competition for 6th-12th grade	❍	❍	❍	❍
eCYBERMISSION: A web-based science, technology, engineering, and mathematics (STEM) competition for 6th-9th grade	❍	❍	❍	❍
High School Internships : Internships in laboratories at colleges throughout the country (REAP and HSAP)	❍	❍	❍	❍
College Internships: At laboratories at colleges throughout the country (URAP)	❍	❍	❍	❍
The Science, Mathematics And Research for Transformation (**SMART**) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	❍	❍	❍	❍
The National Defense Science and Engineering Graduate (**NDSEG**) fellowship offered by the Department of Defense	❍	❍	❍	❍

How did CQL contribute to your educational and professional experiences and/or pursuits?

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Given the opportunity, would you participate in CQL again? Why or Why not?

In a couple of sentences, tell us about your overall satisfaction with the CQL research project/final presentation: What was the most valuable part of that experience?

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:

Rebecca Kruse – rkruse75@vt.edu or Tanner Bateman – tbateman@vt.edu

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

What is your age?		
	Freq.	**%**
18 years	4	6%
19 years	14	20%
20 years	13	18%
21 years	14	20%
22 years	8	11%
23 years	7	10%
24 years	3	4%
25 years	5	7%
26 years	2	3%
27 years	1	1%
Total	**71**	**100%**

Note. Average age = 21.2 years

What is the duration of your 2013 CQL apprenticeship?		
	Freq.	**%**
It is a SUMMER apprenticeship	79	85%
It is a 6-MONTH apprenticeship	4	4%
It is a 9-MONTH apprenticeship	2	2%
It is a 12-MONTH apprenticeship	4	4%
Other (specify):	4	4%
Total	**93**	**100%**

Note. Other = "4-month", "7 month", "summer internship extended 2-3 months", and "summer, then longer through another program".

Did you participate in GEMS as a student?		
	Freq.	**%**
No	84	89%
Yes, one time	5	5%
Yes, two times	1	1%
Yes, three times	4	4%
Total	**94**	**100%**

Have you previously worked as a "near-peer" mentor for GEMS?		
	Freq.	**%**
No	91	97%
Yes, one time	2	2%
Yes, four times	1	1%
Total	**94**	**100%**

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Have you previously worked as a SEAP apprentice?		
	Freq.	**%**
No	72	77%
Yes, one time	12	13%
Yes, two times	8	9%
Yes, three times	2	2%
Total	**94**	**100%**

Have you previously worked as a CQL apprentice? How many times? At which Army Installations(s)?		
	Freq.	**%**
No	78	83%
Yes, one time	13	14%
Yes, two times	2	2%
Yes, three times	1	1%
Total	**94**	**100%**

Have you previously worked as a CQL apprentice? How many times? At which Army Installations(s)?		
	Freq.	**%**
ARL-APG; Aberdeen, MD	5	31%
Unspecified	4	25%
ARL-A; Adelphi, MD	3	19%
ARL (unspecified)	1	6%
USACIL; Fort Gillem, GA	1	6%
USAMRIID; Fort Detrick, MD	1	6%
Walter Reed (WRAIR); Silver Spring, MD	1	6%
Total	**16**	**100%**

At which laboratory are you currently working (select from the list)?						
CQL Site	**Freq.**	**%**		**CQL Site**	**Freq.**	**%**
AMRDEC; Redstone Arsenal, AL	0	0%		**USACEHR; Fort Detrick, MD**	0	0%
ARL-A; Adelphi, MD	24	26%		**USACIL; Fort Gillem, GA**	13	14%
ARL-APG; Aberdeen, MD	35	37%		**USAMRICD; Aberdeen, MD**	4	4%
ECBC; Edgewood, MD	0	0%		**USAMRIID; Fort Detrick, MD**	9	10%
ERDC-CERL; Champaign, IL	5	5%		**Walter Reed (WRAIR); Silver Spring, MD**	3	3%
ERDC-MS; Vicksburg, MS	0	0%		**Other (specify):**	1	1%
NATICK; Natick, MA	0	0%		Other = "Towson University with ARL Aberdeen"		
				Total	**94**	**100%**

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Prior to becoming a CQL apprentice, did you already know someone who works at your laboratory site?		
	Freq.	**%**
Yes - a family member that works at this lab site	15	16%
Yes - a family friend that works at this lab site	20	21%
No - I did not know anyone that works at this lab site	59	63%
Total	**94**	**100%**

Which of the following best describes you?		
	Freq.	**%**
Male	60	64%
Female	33	35%
Choose not to report	1	1%
Total	**94**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	1	1%
Asian or Pacific Islander	20	21%
Black or African American	8	9%
Hispanic or Latino	5	5%
White/Caucasian	55	59%
Some other ethnicity/race	0	0%
Choose not to report	5	5%
Total	**94**	**100%**

What degree are you currently pursuing?		
	Freq.	**%**
Bachelor's	62	66%
Master's	15	16%
Doctor of Philosophy (e.g., Ph.D.)	7	7%
Medical Doctorate (e.g., M.D. or D.O.)	0	0%
I'm a Post Baccalaureate or Post Graduate	7	7%
Other (please specify):	3	3%
Total	**94**	**100%**

Note. Other = "Au.D." (n = 2), and "Just obtained BS in chemistry"

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Which of the following categories best describes the STEM field you are currently pursuing?		
	Freq.	**%**
Engineering	45	48%
Environmental Science	1	1%
Physical Science	9	10%
Chemistry	6	6%
Life Science	9	10%
Medicine / Health	11	12%
Mathematics / Computer Science	0	0%
Social Science	3	3%
Other STEM Field	10	11%
Total	**94**	**100%**

Note. Other = "Forensic Science" (n = 4), "biology and psychology dual degree", "biomaterials engineering(materials science)", "biotechnology", "business administration", "Materials science and engineering", and "Media forensics".

Please take a moment to think about the Science, Technology, Engineering, and Math (STEM) activities that you have participated in during your CQL experience. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
I want to study more Science, Technology, Engineering, or Math (STEM) after participating in CQL	0 (0%)	1 (1%)	2 (2%)	9 (10%)	31 (34%)	49 (53%)	92	**5.36**	0.83
I enjoyed the hands-on / laboratory work during CQL	0 (0%)	0 (0%)	2 (2%)	9 (10%)	20 (22%)	61 (66%)	92	**5.52**	0.76
I learned many new and interesting things during the day-to-day activities in CQL	1 (1%)	1 (1%)	4 (4%)	6 (7%)	30 (33%)	50 (54%)	92	**5.32**	0.98
I like to share the information that I learned in CQL with my peers, friends, and family	0 (0%)	3 (3%)	4 (4%)	14 (15%)	34 (37%)	37 (40%)	92	**5.07**	1.01
I think about the new STEM information I learned in CQL when I am outside of the laboratory	0 (0%)	0 (0%)	3 (3%)	17 (18%)	34 (37%)	38 (41%)	92	**5.16**	0.84
After CQL, I intend to join a STEM-related professional organization	1 (1%)	3 (3%)	2 (2%)	19 (21%)	26 (28%)	41 (45%)	92	**5.05**	1.1
I want learn more about the STEM topics that I was exposed to during CQL	0 (0%)	2 (2%)	2 (2%)	13 (14%)	35 (38%)	40 (43%)	92	**5.18**	0.91
After CQL, I will encourage my peers to study more STEM courses	0 (0%)	1 (1%)	4 (4%)	20 (22%)	30 (33%)	37 (40%)	92	**5.07**	0.95
I will recommend CQL to my friends	0 (0%)	2 (2%)	4 (4%)	9 (10%)	32 (35%)	45 (49%)	92	**5.24**	0.95
After CQL, I want to mentor younger students in learning about STEM	1 (1%)	3 (3%)	10 (11%)	25 (27%)	25 (27%)	28 (30%)	92	**4.67**	1.18

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to think about your CQL MENTOR. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
My CQL mentor frequently worked with me in the laboratory	1 (1%)	5 (5%)	5 (5%)	14 (15%)	27 (29%)	40 (43%)	92	**4.97**	1.22
I learned a lot from my CQL mentor about performing STEM research	0 (0%)	1 (1%)	2 (2%)	8 (9%)	30 (33%)	51 (55%)	92	**5.39**	0.82
My CQL mentor encouraged me to perform a variety of tasks in the laboratory	1 (1%)	1 (1%)	1 (1%)	3 (3%)	28 (30%)	58 (63%)	92	**5.50**	0.86
My CQL mentor helped me to formulate my educational goals	2 (2%)	2 (2%)	4 (4%)	10 (11%)	37 (40%)	37 (40%)	92	**5.05**	1.11
My CQL mentor taught me how to work more effectively in a laboratory	2 (2%)	1 (1%)	5 (5%)	13 (14%)	29 (32%)	42 (46%)	92	**5.09**	1.13
MY CQL mentor spoke with me about my career interests	0 (0%)	4 (4%)	7 (8%)	8 (9%)	36 (39%)	37 (40%)	92	**5.03**	1.09
My CQL mentor helped me become a better writer of scientific research	2 (2%)	1 (1%)	4 (4%)	20 (22%)	29 (32%)	36 (39%)	92	**4.97**	1.11
I would like to work with my CQL mentor again	0 (0%)	2 (2%)	2 (2%)	2 (2%)	26 (28%)	60 (65%)	92	**5.52**	0.83

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = *"Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
My CQL mentor helped me clarify my pathways to achieve my academic goals	0 (0%)	4 (4%)	3 (3%)	27 (29%)	30 (33%)	28 (30%)	92	**4.82**	1.05
My CQL mentor gave me advice about the steps I need to take to achieve my professional goals	0 (0%)	7 (8%)	3 (3%)	17 (19%)	30 (33%)	34 (37%)	91	**4.89**	1.18
My CQL mentor helped me with my CV/Résumé	4 (4%)	19 (21%)	9 (10%)	19 (21%)	21 (23%)	19 (21%)	91	**4.00**	1.56
My CQL mentor will write or help me obtain letters of reference	1 (1%)	3 (3%)	1 (1%)	13 (14%)	28 (31%)	45 (49%)	91	**5.19**	1.06
My CQL mentor taught me about professional and educational networks that will help me in the future	1 (1%)	8 (9%)	2 (2%)	15 (16%)	30 (33%)	36 (39%)	92	**4.88**	1.27
My CQL mentor exposed me to professional organizations that can help me with my career/educational goals	1 (1%)	9 (10%)	2 (2%)	17 (18%)	28 (30%)	35 (38%)	92	**4.82**	1.30
I would recommend my CQL mentor to other students	0 (0%)	0 (0%)	1 (1%)	10 (11%)	20 (22%)	61 (66%)	92	**5.53**	0.73

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = *"Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to consider your UNDERGRADUATE or GRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:

	1	2	3	4	5	6	n	Avg	SD
In school, I had to define a research question or thesis and determine its critical concepts	21 (23%)	41 (46%)	14 (16%)	3 (3%)	5 (6%)	6 (7%)	90	**2.42**	1.39
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	16 (18%)	35 (39%)	16 (18%)	8 (9%)	6 (7%)	8 (9%)	89	**2.74**	1.50
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	11 (12%)	27 (30%)	20 (22%)	14 (16%)	8 (9%)	10 (11%)	90	**3.12**	1.52
In school, I had to organize and synthesize information across academic sources	6 (7%)	25 (28%)	17 (19%)	17 (19%)	10 (11%)	14 (16%)	89	**3.47**	1.55
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	19 (21%)	24 (27%)	19 (21%)	6 (7%)	13 (14%)	9 (10%)	90	**2.97**	1.64
In school, I had to work as part of a team on research projects	11 (12%)	20 (22%)	24 (27%)	10 (11%)	12 (13%)	13 (14%)	90	**3.34**	1.60

Note. Response scale: **1** = "*Never,*" **2** = "*Once per week,*" **3** = *"2 or 3 times per week,*" **4** = "4 or 5 *times per week,*" **5** = "*Every day*," **6** = "*Multiple times per day*".

Please take a moment to consider your CQL research experiences. Use the scale provided to indicate how often you performed each of the following activities IN CQL:

	1	2	3	4	5	6	n	Avg	SD
In CQL, I had to define a research question or thesis and determine its critical concepts	7 (8%)	31 (34%)	22 (24%)	8 (9%)	11 (12%)	11 (12%)	90	**3.20**	1.52
In CQL, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	9 (10%)	24 (26%)	18 (20%)	12 (13%)	13 (14%)	15 (16%)	91	**3.45**	1.63
In CQL, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	9 (10%)	17 (19%)	18 (20%)	14 (15%)	16 (18%)	17 (19%)	91	**3.68**	1.64
In CQL, I had to organize and synthesize information across academic sources	7 (8%)	21 (23%)	15 (16%)	13 (14%)	18 (20%)	17 (19%)	91	**3.71**	1.63
In CQL, I had to determine appropriate ethical and legal uses of published academic research for my own work	12 (13%)	28 (31%)	14 (15%)	6 (7%)	16 (18%)	15 (16%)	91	**3.34**	1.73
In CQL, I had to work as part of a team on research projects	11 (12%)	11 (12%)	6 (7%)	10 (11%)	24 (27%)	28 (31%)	90	**4.21**	1.78

Note. Response scale: **1** = "*Never,*" **2** = "*Once per week,*" **3** = *"2 or 3 times per week,*" **4** = "4 or 5 *times per week,*" **5** = "*Every day*," **6** = "*Multiple times per day*".

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Please take a moment to consider your UNDERGRADUATE or GRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In school, I used advanced science or engineering equipment	13 (15%)	23 (26%)	34 (39%)	3 (3%)	5 (6%)	9 (10%)	87	**2.90**	1.44
In school, I cleaned and cared for the equipment in a science or engineering laboratory	22 (25%)	26 (30%)	18 (21%)	6 (7%)	6 (7%)	9 (10%)	87	**2.71**	1.59
In school, I calibrated laboratory equipment for experimentation	33 (38%)	27 (31%)	12 (14%)	4 (5%)	5 (6%)	6 (7%)	87	**2.30**	1.50
In school, I created solutions from reagents in preparation for experimental procedures	36 (41%)	27 (31%)	10 (11%)	5 (6%)	3 (3%)	6 (7%)	87	**2.20**	1.47
In school, I used proper safety procedures when handling equipment and material in the lab	7 (8%)	28 (32%)	18 (21%)	4 (5%)	20 (23%)	10 (11%)	87	**3.37**	1.59
In school, I employed advanced measurement techniques in science or engineering procedures	18 (21%)	26 (30%)	20 (23%)	5 (6%)	10 (11%)	8 (9%)	87	**2.85**	1.57

Note. Response scale: **1** = "*Never*," **2** = "*Once per week*," **3** = *"2 or 3 times per week*," **4** = "4 or 5 *times per week*," **5** = "*Every day*," **6** = "*Multiple times per day*".

Please take a moment to consider your CQL research experiences. Use the scale provided to indicate how often you performed each of the following activities DURING CQL:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In CQL, I used advanced science or engineering equipment	8 (9%)	11 (13%)	15 (17%)	7 (8%)	18 (21%)	28 (32%)	87	**4.15**	1.74
In CQL, I cleaned and cared for the equipment in a science or engineering laboratory	16 (18%)	11 (13%)	9 (10%)	7 (8%)	20 (23%)	24 (28%)	87	**3.87**	1.90
In CQL, I calibrated laboratory equipment for experimentation	31 (36%)	13 (15%)	17 (20%)	8 (9%)	8 (9%)	10 (11%)	87	**2.76**	1.75
In CQL, I created solutions from reagents in preparation for experimental procedures	42 (48%)	9 (10%)	11 (13%)	4 (5%)	7 (8%)	14 (16%)	87	**2.62**	1.94
In CQL, I used proper safety procedures when handling equipment and material in the lab	9 (10%)	6 (7%)	10 (11%)	3 (3%)	24 (28%)	35 (40%)	87	**4.52**	1.72
In CQL, I employed advanced measurement techniques in science or engineering procedures	14 (16%)	10 (11%)	10 (11%)	7 (8%)	18 (21%)	28 (32%)	87	**4.02**	1.89

Note. Response scale: **1** = "*Never*," **2** = "*Once per week*," **3** = *"2 or 3 times per week*," **4** = "4 or 5 *times per week*," **5** = "*Every day*," **6** = "*Multiple times per day*".

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how accurately each statement describes you AFTER CQL:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
After CQL, I am more confident in my ability to formulate hypotheses and design experiments to test them	0 (0%)	2 (2%)	1 (1%)	22 (25%)	40 (46%)	22 (25%)	87	**4.91**	0.87
After CQL, I am more confident that I can analyze data and understand the results of an experiment	1 (1%)	1 (1%)	1 (1%)	12 (14%)	40 (46%)	32 (37%)	87	**5.13**	0.91
After CQL, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	1 (1%)	2 (2%)	2 (2%)	10 (11%)	35 (40%)	37 (43%)	87	**5.15**	1.01
After CQL, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	0 (0%)	0 (0%)	3 (3%)	13 (15%)	43 (49%)	28 (32%)	87	**5.10**	0.78
After CQL, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	4 (5%)	3 (3%)	6 (7%)	13 (15%)	35 (40%)	26 (30%)	87	**4.72**	1.31
After CQL, I am more confident in my ability to complete academic literature reviews for my own research projects	0 (0%)	3 (3%)	4 (5%)	21 (24%)	31 (36%)	28 (32%)	87	**4.89**	1.03
After CQL, I am more confident that I can make significant research contributions as an effective part of a research team	0 (0%)	0 (0%)	1 (1%)	11 (13%)	34 (39%)	41 (47%)	87	**5.32**	0.74

Note. Response scale: **1** = "*Not at all like me,*" **2** = "*Not like me,*" **3** = *"Not much like me,*" **4** = "*Somewhat* like *me*," **5** = "*Like me*," **6** = "*Just like me*".

Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?		
	Freq.	**%**
2-year/Associate's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	0	0%
2-year/Associate's degree in something other than a STEM-related field.	0	0%
Bachelor's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	9	10%
Bachelor's degree in something other than a STEM-related field.	0	0%
Master's degree in a STEM-related field.	29	33%
Master's degree in something other than a STEM-related field.	2	2%
Doctoral degree in a STEM-related field.	46	52%

Doctoral degree in something other than a STEM-related field.	3	3%
Total	**89**	**100%**

Consider the highest level of education that you plan to pursue (your response to the question above). Using the scale provided, please tell us how certain you are that you will be able to do each of the following?

	1	2	3	4	5	6	n	Avg.	SD
I will be admitted into my program of choice	1 (1%)	3 (3%)	7 (8%)	25 (28%)	23 (26%)	30 (34%)	89	**4.75**	1.17
I will attend college to pursue this educational degree	0 (0%)	0 (0%)	0 (0%)	8 (9%)	17 (19%)	64 (72%)	89	**5.63**	0.65
I will get good grades in my classes	0 (0%)	0 (0%)	3 (3%)	17 (19%)	30 (34%)	39 (44%)	89	**5.18**	0.86
I will be able to overcome any obstacle between me and this educational degree	0 (0%)	0 (0%)	2 (2%)	15 (17%)	30 (34%)	42 (47%)	89	**5.26**	0.82
I will finish this degree	0 (0%)	1 (1%)	1 (1%)	10 (11%)	22 (25%)	55 (62%)	89	**5.45**	0.83

Note. Response scale: **1** = "*Not at all certain,*" **2** = "*Uncertain,*" **3** = *"Relatively uncertain,*" **4** = "*Relatively Certain,*" **5** = "*Certain*," **6** = "*Very Certain*".

Use the scale provided to tell us how certain you are that you will do the following activities in the future: (n=88)

	1	2	3	4	5	6	n	Avg.	SD
I will apply for jobs in a STEM-related field	0 (0%)	1 (1%)	5 (6%)	5 (6%)	20 (22%)	58 (65%)	89	**5.45**	0.92
I will get a job in a STEM field	0 (0%)	3 (3%)	2 (2%)	15 (17%)	22 (25%)	47 (53%)	89	**5.21**	1.03
I will build a career around my STEM skills	0 (0%)	2 (2%)	4 (4%)	9 (10%)	23 (26%)	51 (57%)	89	**5.31**	0.98
I will pursue STEM jobs with the Army/Department of Defense (DoD)	4 (4%)	4 (4%)	29 (33%)	22 (25%)	15 (17%)	15 (17%)	89	**3.96**	1.33
I will build a STEM career with the Army/DoD	4 (4%)	7 (8%)	32 (36%)	25 (28%)	10 (11%)	11 (12%)	89	**3.71**	1.27

Note. Response scale: **1** = "*Not at all certain,*" **2** = "*Uncertain,*" **3** = *"Relatively uncertain,*" **4** = "*Relatively Certain,*" **5** = "*Certain*," **6** = "*Very Certain*".

Which of the following categories best describes the STEM field that you want to build your career around?

	Freq.	%
Engineering	43	48%
Environmental Science	0	0%

Physical Science	5	6%
Chemistry	6	7%
Life Science	8	9%
Medicine / Health	15	17%
Mathematics / Computer Science	3	3%
Social Science	2	2%
Other STEM Field	5	6%
A field unrelated to STEM	2	2%
Total	**89**	**100%**

Use the scale provided to tell us how much you agree or disagree with the following statements:

	1	2	3	4	5	6	n	Avg.	SD
In CQL, I learned about new STEM-related jobs/careers.	1 (1%)	10 (11%)	8 (9%)	25 (28%)	22 (25%)	22 (25%)	88	**4.40**	1.33
In CQL, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	1 (1%)	8 (9%)	4 (5%)	18 (20%)	35 (40%)	22 (25%)	88	**4.64**	1.23
In CQL, I became interested in a STEM job/career I did not know about before.	2 (2%)	14 (16%)	17 (20%)	19 (22%)	23 (26%)	12 (14%)	87	**3.95**	1.37
In CQL, I became interested in a new STEM-related job/career with the Army/DoD	4 (5%)	12 (14%)	11 (13%)	23 (26%)	22 (25%)	16 (18%)	88	**4.08**	1.44

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = "*Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Of the new STEM jobs/careers that you learned about, which three did you find MOST INTERESTING? (Please list them): (n = 45 apprentices reporting)

Job	Freq.	%		Job	Freq.	%
Material Scientist	5	11%		**biochemist**	1	2%
DNA Analyst	4	9%		**Biomechanical Research**	1	2%
Defense contractor	3	7%		**Cellular Molecular Biology**	1	2%
Materials engineer	3	7%		**Clinical Trials**	1	2%
Robotics/Mechatronics	3	7%		**Computer Programmer**	1	2%
Trace Analyst	3	7%		**Cost analyst for government projects**	1	2%
Audiology	2	4%		**Device Fabrication Engineer**	1	2%
Digital Forensic Examiner	2	4%		**Digital Photography Analyst**	1	2%
Electrical Engineer	2	4%		**Digital System Design**	1	2%
Epidemiology	2	4%		**Dismounted soldier group**	1	2%

Lab Manager	2	4%		**Doctor**	1	2%
Latent Print Examiner	2	4%		**Expeditionary Forensics Division at USACIL**	1	2%
Mechanical Engineer	2	4%		**FBI-Visiting Scientist**	1	2%
Microbiologist	2	4%		**Firearms Analyst**	1	2%
Principal Investigator	2	4%		**Forensic chemist**	1	2%
Product Development Engineer	2	4%		**Forensic Science**	1	2%
Toxicologist	2	4%		**Forensic toxicology**	1	2%
3D printing	1	2%		**FXD Analyst**	1	2%
Aeronautics/Astronautics	1	2%		**Independent Researcher**	1	2%
Army Officer for graduate studies	1	2%		**In-house technician**	1	2%
Army-Chemist for FXD	1	2%		**Laboratory Technician**	1	2%
Automotive Design Engineer	1	2%		**Lobbyist for the USACIL and/or FXD**	1	2%
Behavioral analyst	1	2%		**M.D. Commander**	1	2%

Note. % = percentage of apprentices that listed specific job.

CONTINUED – Of the new STEM jobs/careers that you learned about, which three did you find MOST INTERESTING? (Please list them): (n = 45 apprentices reporting)

Job	Freq.	%		Job	Freq.	%
Making microchips	1	2%		**Research in the medical field**	1	2%
Management within USACIL and/or FXD	1	2%		**Research Scientist**	1	2%
Mission simulation	1	2%		**Research with the DoD**	1	2%
Molecular Biologist	1	2%		**Rotorcraft Design Engineer**	1	2%
MPH/MD Researcher	1	2%		**Scientist & Engineer (S&E)**	1	2%
Neurophysics	1	2%		**Scientist stretching cells on scaffolds**	1	2%
Optics	1	2%		**Scientist studying bone fractures**	1	2%
paint researcher	1	2%		**Scientist studying plasma technologies**	1	2%
Pathologist	1	2%		**Signal Processing**	1	2%
PhD then joining the army as a CPT	1	2%		**Software Engineer**	1	2%
Physician Assistant	1	2%		**STEM Education**	1	2%
Physicist	1	2%		**synthetic biologist**	1	2%
Post Doctoral Research Fellow	1	2%		**Technical Writer**	1	2%
Professor	1	2%		**Wind Turbine Design Engineer**	1	2%
Research Assistant	1	2%		**WMRD**	1	2%
				Total # of Jobs Listed	**102**	**100%**

Note. % = percentage of apprentices that listed specific job.

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how much you agree or disagree with the following statements about the Department of Defense (DoD):									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
The Army/DoD has made many important contributions to science and engineering with applied research	2 (2%)	0 (0%)	0 (0%)	5 (6%)	31 (36%)	49 (56%)	87	**5.41**	0.91
Army/DoD researchers contribute much more to society than just "warfare" advancements	0 (0%)	1 (1%)	1 (1%)	8 (9%)	29 (33%)	48 (55%)	87	**5.40**	0.80
Army/DoD researchers use cutting-edge technology to solve the world's problems	0 (0%)	0 (0%)	2 (2%)	8 (9%)	32 (37%)	45 (52%)	87	**5.38**	0.75
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	0 (0%)	2 (2%)	0 (0%)	13 (15%)	31 (36%)	41 (47%)	87	**5.25**	0.88
After CQL, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life	0 (0%)	2 (2%)	0 (0%)	11 (13%)	28 (33%)	45 (52%)	86	**5.33**	0.87

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = *"Somewhat Disagree,*" **4** = "*Somewhat Agree,*" **5** = "*Agree,*" **6** = "*Strongly Agree*".

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Have you ever participated in or heard about any of the following programs?				
	Yes, I participated	**I would have participated but it was not available in my area / I did not qualify for this program**	**I am interested in participating in this program**	**I have never heard about this program**
Junior Solar Sprint (JSS): A solar-car building and race competition for 6th – 8th grade	0 (0%)	1 (1%)	1 (1%)	84 (98%)
Junior Science and Humanities Symposium (JSHS): A high school STEM research competition	1 (1%)	1 (1%)	1 (1%)	83 (97%)
UNITE: An engineering summer program for high school students from underserved groups	1 (1%)	0 (0%)	0 (0%)	85 (99%)
West Point Bridge Contest: A computer-based engineering design competition for 6th – 12th grade	1 (1%)	3 (3%)	1 (1%)	81 (94%)
eCYBERMISSION: A Web-based science, technology, engineering, and mathematics (STEM) competition for 6th – 9th grade	1 (1%)	2 (2%)	2 (2%)	81 (94%)
High School Internships: Internships in laboratories at colleges throughout the country (**REAP** and **HSAP**)	2 (2%)	10 (12%)	3 (4%)	69 (82%)
College Internships: At laboratories at colleges throughout the country **(URAP)**	8 (9%)	8 (9%)	21 (25%)	48 (56%)
The Science, Mathematics And Research for Transformation **(SMART)** scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	1 (1%)	19 (22%)	42 (48%)	25 (29%)
The National Defense Science and Engineering Graduate **(NDSEG)** fellowship offered by the Department of Defense	0 (0%)	7 (8%)	25 (29%)	55 (63%)

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

How did CQL contribute to your educational and professional experiences and/or pursuits? (n = 65)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
STEM Pathway		**48**	
	Clarified apprentices' educational goals and/or career aspirations	17	• "[CQL] helped me understand more about what kind of career path I want…immediate graduate work vs. immediate job." • "I am now potentially interested in going into the field of nuclear physics after this experience." • "…now I know that I do not want to do this for the rest of my life."
	Bolstered apprentices' resume for grad school, jobs, and/or scholarship applications	10	• "CQL helped provide the resume content to get me considered at many high-level job opportunities and eventually get hired on by my employer of choice, performing my 'dream job'."
	Apprentices' intend to pursue research opportunities at their university	6	• "I am interested in working at the operant lab at my school now."
	Prepared apprentices' for a specific career	5	• "I learned a lot about the professional engineering workplace and I am much more prepared for a fulltime job in the near future"
	Apprentices' gained a professional network	5	• "It allowed me to have the contacts necessary to pursue future career opportunities."
	Apprentice identified DoD/Govt. service career opportunities	5	• "It helped me understand how a civilian can work for a military branch doing full time research." • "It helped me confirm that I want to work for DoD research."
Academic Research Activities		**39**	
	Apprentice acquired STEM knowledge and research skills and abilities	25	• "This experience improved my research skills and knowledge about the field of biomechanics." • "I learned how to program in Python after coming in with no programming experience. I was able to hone my data analysis skills. I learned a lot about rotorcraft dynamics."
	Apprentice acquired the ability to conduct research independently	5	• "It allowed me to gain experience in developing an independent research project and being able to carry it out from start to end."
	Apprentice gained presentation / communication skills	4	• "Getting the chance to present my summer work to the ARL Dvision Chiefs and DIrectors as well as the ARL Fellows gave me valuable experience in my presentation skills."

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

	Apprentice gained a research topic to use in college	3	• "Performing research that may lead to my eventual thesis."
	Apprentice gained an understanding of advanced research	2	• "CQL provided me with a better understanding of graduate level research."
Hands-on Research Activities		**23**	
	Apprentice gained experience with advanced laboratory work	19	• "I had the opportunity to work with top of the line lab equipment." • "The CQL program taught me how to operate various advanced laboratory equipment which will be helpful to continue my education."
	Apprentice gained experience with advanced research techniques	2	• "I learned many new techniques that I believe will give me an advantage when applying to future research positions."
	Apprentice was able to conduct real-world applications of school content	2	• "It showed me real world applications of concepts I learned in school."
Confidence in Research Skills		**7**	
	Apprentice gained research confidence	7	• "After my experience, I feel more able to conduct research experiments and analyze data to obtain the desired results." • "I feel more confident in my ability to learn and work in a fast-paced environment and pick up things on the fly."
Effective Mentorship		**3**	
	Apprentice benefitted from mentorship	3	• "Networking and being able to ask career questions of my mentors and peers gave me insight I would not have had the opportunity to ask otherwise." • "Their guidance and mentorship has allowed me to feel confident about working in STEM related research."
Satisfaction with program		**2**	
	Apprentice was satisfied with CQL	2	• "I have been a participant in 6 other STEM programs before, but CQL was by far the most rewarding one of them all."
Attitude toward Army / DoD		**1**	
	Apprentice gained an appreciation of Army / DoD research	1	• "Although I am uncertain whether my future career will include the department of defense, their contributions to society have made we want to pursue a meaningful career to help others."

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

Given the opportunity, would you participate in CQL again? Why or Why not? (n = 68)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Yes		**55**	
Academic Research Activities		**31**	
	It was a positive learning experience	23	• "It was a great learning experience." • "I gained so much knowledge about different fields while participating in this program."
	Networking with others	4	• "I would participate again because of the opportunities to network and learn from other expert professionals in my field."
	Personal development	3	• "I feel like this definitely improved me as a person as well as a student, researcher, and future employee."
	Gained experience with writing research papers	1	• "[I learned about] the nuances of writing research papers."
General Satisfaction		**15**	
	CQL was a great experience	7	• "This is the most rewarding program I have been a part of and I am lucky enough to be able to say I got the chance to be part of it." • "My experience was highly positive."
	Satisfied with the research being done	6	• "This ability to build batteries "in air" instead of an Ar glovebox was a one-of-a-kind experience not many colleges or companies are capable of."
	Wanted to accomplish research	1	• "There are a number of projects my mentor and I discussed working on in the future, including potential publications in important journals."
	Acquired novel experiences	1	• "It introduced me to many experiences I would not have otherwise had if I did not participate."
Hands-On Research Activities		**13**	
	Getting hands-on experience in the lab	11	• "The program gave hands-on experience as well as an idea of what laboratories are like in the real world."
	Enjoyed conducting research	1	• "I am very interested in learning about [the projects] by being involved.
	Translate concepts from class to real world	1	• "It helps me to put the concepts that I learn in my classes to work and to something worthwhile."
Other		**13**	
	Positive environment	10	• "The opportunity because the people involved in the program where fantastic to work with."
	Monetary benefits	2	• "The stipend was nice."
	Able to work within teams	1	• "[I enjoyed] working in teams to solve new problems.
STEM Pathway		**9**	

	CQL is a great opportunity	4	• "Yes, it was an amazing opportunity and I could not be more grateful."
	Helps individuals pursue a career in research	3	• "I feel confident in my ability to pursue a career and catch on quickly to new ways of doing things."
	Furthered career path	1	• "I have learned a lot and been brought closer to my career goals."
No		**3**	
	Will be getting a different job/experience	3	• "After undergraduate I will pretty much be tied down to either an academic lab or an industrial job." • "I will be graduating soon and will be looking for a full time position or higher degree."
Conditional Yes		**2**	
	If provided with choice of location	1	• "If I was given the opportunity to choose where."
	If provided with research area of interest	1	• "I would if I was given a real Material Science job that was in an area of interest to me."
Maybe/Unsure		**2**	
	Availability of programs	1	• "Possibly, depending on what was available."
	Unsure	1	• "Maybe, TBD."
Awareness of STEM Careers in the Army/DoD		**1**	
	Discovered career opportunities in the DoD	1	• "[CQL] not only taught me about science research, but also about the types of work that is done in the DoD."

Appendix B:
2013 CQL Apprentice Questionnaire and Data Summary

In a couple of sentences, tell us about your overall satisfaction with the CQL research project/final presentation: What was the most valuable part of that experience? (n = 59)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Satisfaction with program		**19**	
	Personal development	8	• "It gave me the opportunity to work on my presentation skills and share with others about what I did over the summer." • "[My most valuable takeaway was] an increased overall self-confidence in my engineering skills.
	Enjoyed piecing together the research	4	• "…figuring out how to take all of the knowledge about my research that I had accumulated and organizing them into a well-thought out collection of results and conclusions."
	Enjoyed seeing the final result	3	• "…looking back at what you have researched and put in a lot of time for and finally seeing it work out."
	Generally satisfied with the program	3	• "It was good."
	Satisfied with available resources	1	• "It was a great opportunity to do a real research project where I had many resources at my disposal."
Academic Research Activities		**16**	
	It was a positive learning experience	8	• "I have learned about things that I never knew existed. I also learned about and was given the opportunity to participate in ground breaking research." • "The most valuable part of this experience was learning about subjects which interested me even if I were not already trained or educated in those subject areas.
	Working on teams	6	• "The most valuable part was learning to work with other people to get my goals accomplished on my schedule." • "Working alongside of researchers."
	Networking with others	2	• "I think the networking I made and continue to take advantage of was the most beneficial part. Those professional and personal relationships are invaluable to me and still contribute to my success today."
Hands-on / Laboratory Research Activities		**15**	
	Enjoyed presenting material	9	• "The most valuable part of this experience is to get experience presenting research to your peers and colleagues." • "The most valuable part of this experience was learning how to make a presentation and be prepared to present on short notice."

	Gained practical experience in the lab	5	• "The most valuable experience has been working hands on in a lab by myself and learning different techniques in scientific procedures."
	Enjoyed hands-on activities	**1**	• "The most valuable part of the experience was the "hands on the bench" approach that Dr. McNutt and his team encouraged."

In a couple of sentences, tell us about your overall satisfaction with the CQL research project/final presentation: What was the most valuable part of that experience? (n = 59)

Broad Theme	Narrow Theme(s)	Freq.	Example Response(s)
Not yet complete with the project		**4**	
Dissatisfaction with the program		**3**	
	Protocol distracted from work	2	• "It was difficult to find time to work on the research project because first there are a lot of hurdles with forms, getting access to computers, getting a computer, safety training, etc." • "It seemed like most of the time this summer was spent working around security paperwork and computer access issues (as well as furlough days) that ate away precious time that could have been spent on research."
	Have presentation later	1	• "The presentation could have taken place a bit later to give students more time to prepare and have results."
Effective Mentorship		**2**	
	Mentor(s) provided good feedback	2	• "They gave me good feedback on my presentation and my paper that I will take with me for future presentations or papers that I submit."
	Worked one-on-one with mentor	1	• "Being able to work one-on-one with the principal investigator of an experiment was very rewarding as I could ask questions directly of the person in charge."
STEM Pathway		1	
	Published work from CQL	1	• "I was very enthused to the fact that my research project was vital to the Latent Print community and I was able to write my first research paper to be published in the Journal of Forensic Identification."

2013 College Qualified Leaders: Mentor Rubrics & Questionnaire

Thank you for your participation in this study about the 2013 College Qualified Leaders (CQL) Program. The following assessment will collect information about you and your CQL apprentice(s). The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support CQL.

About this survey:

- This research protocol has been approved for use with human subjects by the Virginia Tech IRB office. Although this assessment is not anonymous, it is CONFIDENTIAL; prior to analysis and reporting, responses will be de-identified and no one will be able to connect your responses to you or your apprentice's name.
- Additionally, only AEOP evaluation personnel will have access to completed assessments and personal information will be stored securely.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time.
- If you provide your email address, the AEOP may contact you in the future to ask about you or your CQL apprentice(s).
- We do hope that you will finish the survey because your responses will give CQL valuable information for improvement and for generating reports for our supporting organizations

By choosing to completed this assessment, you are providing your consent to participate in the CQL research/evaluation study

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Tim Donovan, American Society for Engineering Education
Project Assistant, CQL
(202) 649-3833, T.Donovan@asee.org

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Provide your personal information below (optional):

First Name: _____

Last Name: _____

Email Address: _____

In total, how many CQL apprentices have you mentored through the years?

Total # of apprentices mentored: _____, apprentices.

In the past, have you ever worked as a CQL apprentice?

- ❍ No
- ❍ Yes - for how many years? _____

Do you serve as a mentor for apprentices or students in programs other than CQL?

- ❍ No
- ❍ Yes - which program(s)? _____

In which laboratory are you working? (select from the list)

- ❍ AMRDEC; Redstone Arsenal, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ECBC; Edgewood, MD
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ NATICK; Natick, MA
- ❍ USACEHR; Fort Detrick, MD
- ❍ USACIL; Fort Gillem, GA
- ❍ USAMRICD; Aberdeen, MD
- ❍ USAMRIID; Fort Detrick, MD
- ❍ Walter Reed (WRAIR); Silver Spring, MD
- ❍ Other (specify): _____

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your ethnicity/race?

- ❍ American Indian or Alaska Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White or Caucasian
- ❍ Some other ethnicity/race: _____
- ❍ Choose not to report

Which of the following categories best describes your research field?

- ❍ Engineering (e.g., technology, robotics, computers, etc.)
- ❍ Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)
- ❍ Physical Science (e.g., physics, astronomy, etc.)
- ❍ Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)
- ❍ Life Science (e.g., biology, animal science, ecology, etc.)
- ❍ Medicine / Health (e.g., behavioral science, medicine, public health, etc.)
- ❍ Mathematics / Computer Science
- ❍ Social Science (e.g., sociology, psychology, economics, etc.)
- ❍ Other STEM field: _____

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please take a moment to think about your CQL mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I frequently worked with my CQL apprentice(s) in the laboratory	❍	❍	❍	❍	❍	❍
I taught my CQL apprentice(s) about performing STEM research	❍	❍	❍	❍	❍	❍
I encouraged my CQL apprentice(s) to perform a variety of tasks in the laboratory	❍	❍	❍	❍	❍	❍
I helped my CQL apprentice(s) formulate their educational goals	❍	❍	❍	❍	❍	❍
I taught my CQL apprentice(s) how to work more effectively in a laboratory	❍	❍	❍	❍	❍	❍
I spoke with my CQL apprentice(s) about their career interests	❍	❍	❍	❍	❍	❍
I helped my CQL apprentice(s) be better writers of scientific research	❍	❍	❍	❍	❍	❍
I would like to work with my CQL apprentice(s) again	❍	❍	❍	❍	❍	❍

Use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I helped my CQL apprentice(s) clarify their educational goals and pathways	❍	❍	❍	❍	❍	❍
I provided guidance to my CQL apprentice(s) about the steps they will need to achieve their professional and educational goals	❍	❍	❍	❍	❍	❍
I helped my CQL apprentice(s) draft their CV/Résumé	❍	❍	❍	❍	❍	❍
I will write or help my CQL apprentice(s) obtain letters of reference	❍	❍	❍	❍	❍	❍
I introduced my CQL apprentice(s) to professional and educational networks that will help them in the future	❍	❍	❍	❍	❍	❍
I exposed my CQL apprentice(s) to professional organizations that can help them pursue their career/educational goals	❍	❍	❍	❍	❍	❍
My CQL apprentice(s) were interested in pursuing AEOP programs in the future	❍	❍	❍	❍	❍	❍
I am interested in mentoring more CQL apprentices in the future	❍	❍	❍	❍	❍	❍
I would recommend my CQL apprentice(s) for future Army internships	❍	❍	❍	❍	❍	❍

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any CQL mentor activities related to educating your apprentice(s) about STEM-related careers. Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I educated my CQL apprentice(s) about a wide variety of STEM jobs/careers.	❍	❍	❍	❍	❍	❍
I educated my CQL apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
During CQL, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	❍	❍	❍	❍	❍	❍
My CQL apprentice(s) expressed a lot of interest about pursuing a STEM career	❍	❍	❍	❍	❍	❍
My CQL apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	❍	❍	❍	❍	❍	❍
My CQL apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	❍	❍	❍	❍	❍	❍

Please describe the ways in which you educated your CQL apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Please describe any challenges you faced when educating your CQL apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Please describe how CQL could better support you in your efforts to educate your CQL apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any CQL mentor activities related to educating your apprentice(s) about programs offered by the Army Education Outreach Program (AEOP). Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I know about the Junior Science & Humanities Symposium (JSHS): the national science competition offered by the AEOP	❍	❍	❍	❍	❍	❍
I encouraged my apprentice(s) to submit his/her research project/final report to JSHS	❍	❍	❍	❍	❍	❍
My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS	❍	❍	❍	❍	❍	❍
I know about High School Internship programs offered by the AEOP: The Research in Engineering Apprenticeship Program (REAP) & the High School Apprenticeship Program (HSAP)	❍	❍	❍	❍	❍	❍
I know about the College Internship programs offered by the AEOP: The Undergraduate Research Apprenticeship Program (URAP)	❍	❍	❍	❍	❍	❍
I provided information to my apprentice(s) about one or more AEOP program(s)	❍	❍	❍	❍	❍	❍
My apprentice(s) expressed interest in pursuing AEOP programs in the future	❍	❍	❍	❍	❍	❍
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	❍	❍	❍	❍	❍	❍
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	❍	❍	❍	❍	❍	❍
I am interested in mentoring more CQL apprentices in the future	❍	❍	❍	❍	❍	❍
I would recommend my CQL apprentice(s) for future Army internships	❍	❍	❍	❍	❍	❍

Please describe the ways in which you educated your CQL apprentice(s) about AEOP programs:

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please describe any challenges you faced when educating your CQL apprentice(s) about AEOP programs.

Please describe how CQL could better support you in your efforts to educate your CQL apprentice(s) about AEOP programs.

Rubrics for Rating Apprentices' Skills, Abilities, and Final Project(s) Instructions:

- **Please make sure that you complete a set of the following rubrics for each apprentice that you worked with this summer. If you worked with more than one apprentice, you will be prompted to enter their name and rate them later in the survey.**
- **We have already collected your name but we also need the name of your apprentice(s) to connect their questionnaire to yours. However, reports will never contain any personally identifiable information and results are only reported in the aggregate.**
- **When filling out the assessment tool below, please ensure that you are basing your responses on behavior or work that you have personally witnessed or reviewed.**

What is your apprentice's name?

First Name: _____

Last Name: _____

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "No Experience" and 6 = "Expert". Please rate [Apprentice's name]'s laboratory skill level.

- (1): Student is confused about the lab equipment and cannot use it effectively or safely.
- (2): Can identify the equipment and components. Knows about equipment care and safety but cannot consistently perform operations
- (3): Can perform rudimentary operations with equipment under supervision. Periodically violates proper safety and equipment care protocols
- (4): Can execute basic operations independently. Still needs periodic supervision for safety and equipment care
- (5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision
- (6): Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed

In the rubric below 1 = "No Experience" and 6 = "Expert". Please rate [Apprentice's name]'s level of skill with the Data Collection Techniques (e.g., Lab, Research, and/or Measurement Techniques) that are used in your laboratory.

- (1): Student is confused about techniques, how to perform them, and their importance. Training from a supervisor is needed regularly
- (2): Is beginning to understand techniques and their importance with supervision. Results are not useful at this point
- (3): Understands techniques and their importance but supervision is needed to perform them. Results are only useful when operations have been supervised heavily
- (4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor
- (5): Understands and uses techniques competently without supervision. Yielded results are useful
- (6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s scientific teamwork/collaboration abilities in your laboratory?

- (1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions
- (2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates
- (3): Attempts but rarely offers unique ideas to the team or manages to retain information from teammates. Occasionally late with task completion. Congenial but sometimes indifferent toward teammates
- (4): Occasionally articulates alternative ideas to the team but struggles to synthesize multiple points of view. Is usually on time with task completion. Is polite and positive with teammates
- (5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates
- (6): Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s scientific reasoning skills/abilities?

- (1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles
- (2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles
- (3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles
- (4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles
- (5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research
- (6): Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s information literacy skills/abilities?

- (1): Information searches are not connected to research needs and search is done entirely via web search engines. No information from sources is included nor consideration for sources
- (2): Information searches are vaguely tied to research needs and search is not systematic in nature. Sources are often not credible, plagiarism is evident, and ethical uses are not considered
- (3): Sometimes does not discern needed information and how or where to search for it. Sources are sometimes not credible and ethical uses of information are compromised occasionally
- (4): Has a rudimentary understanding of needed information and how or where to search for it. Finds mostly credible sources and understands that plagiarism is unacceptable
- (5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses
- (6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s quantitative literacy skills/abilities?

- (1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation
- (2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation
- (3): Sometimes misunderstands quantitative information which results in inaccurate sets of findings. Judgments are occasionally not based on results and may not consider some limitations
- (4): Converts quantitative information into results but they are occasionally inaccurate. Judgments and conclusions are based on results but sometimes incomplete while consideration for limitations may also be incomplete during derivation
- (5): Adequately converts and interprets quantitative information into an accurate set of results. Applies the results of analysis to judgments and conclusions while considering assumptions and limitations in their derivation
- (6): Expertly converts and interprets quantitative information into a comprehensive set of accurate results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Final Project Rubric

- **If [Apprentice's name] has completed their final research project -- please use the following rubrics to rate the quality of [Apprentice's name]'s work on their project (i.e., their research report or research presentation)**
- **If [Apprentice's name] has not completed their final research project -- please do not use the following rubrics.**

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Introduction/Purpose?

- ❍ (1): The student provides no real purpose and makes little to no connection with existing research
- ❍ (2): The purpose of the research evades the student. Connections with existing research are often inaccurate or misinterpreted
- ❍ (3): Only partially understands the purpose of the research. Connections with existing research are sometimes inaccurate
- ❍ (4): The purpose of the research is accurate but sometimes unclear. Connections with existing research are incomplete
- ❍ (5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague
- ❍ (6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Methods (e.g., description of equipment & procedures)?

- ❍ (1): The student provides no list or description of the equipment or procedures for this study
- ❍ (2): Equipment and procedures are inaccurately listed and described. Replication would be impossible
- ❍ (3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult
- ❍ (4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information
- ❍ (5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification
- ❍ (6): Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Results (e.g., data analysis, interpretation & findings)

- ❍ (1): Does not report or analyze data. Interpretation of findings is non-existent or not based on the provided evidence
- ❍ (2): Analyzes data incorrectly. Interpretation of results is inaccurate.
- ❍ (3): Misunderstands some data analyses and makes several mistakes. Makes some errors interpreting results. No synthesis of findings
- ❍ (4): Understands data analysis but makes one or two mistakes. Only rudimentary interpretation of results. Synthesis of findings is incomplete
- ❍ (5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear
- ❍ (6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Conclusions

- (1): No conclusions, limitations, or future directions are offered
- (2): Discussion of findings is unstructured and does not tie back to the research question very well. Barely touches on limitations
- (3): Vaguely ties the findings back to the research questions. Limitations are only touched on. No future directions are offered
- (4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed
- (5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus
- (6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Structure?

- (1): Does not include or distinguish between an abstract, body, appendix, or bibliography
- (2): Missing two or more components (abstract, body, appendix, or bibliography). Ordering, labeling, and grammar are not acceptable
- (3): Missing one component (abstract, body, appendix, or bibliography). Order of sections is disjointed or mislabeled. Grammar is minimally acceptable
- (4): Abstract, body, appendices, citations, and bibliography are included with mistakes. Order and labeling of sections is present but not always clear. Grammar is adequate
- (5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality
- (6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Oral Communication?

- (1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)
- (2): Fails to present one intro, purpose, an/or conclusion. Very few and non-credible supporting materials are used
- (3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best
- (4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question
- (5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility
- (6): Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility

Do you have any other comments or input to provide us regarding [Apprentice's name]'s final project?

Do you have any other comments or input to provide us regarding your CQL apprentice?

[Respondents who report mentoring more than one apprentice are prompted to provide rubric ratings and information for up to 10 apprentices. Otherwise, they are directed immediately to the final question below.]

Please take a moment to tell us about any successes and/or challenges that you or your apprentice(s) experienced during CQL this year:

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:

Rebecca Kruse – rkruse75@vt.edu or Tanner Bateman – tbateman@vt.edu

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

In total, how many CQL apprentices have you mentored through the years? (Avg. = 2.64 apprentices, SD = 2.63)						
# of apprentices	**Freq.**	**%**		**# of apprentices**	**Freq.**	**%**
10	1	5%		4	1	5%
9	0	0%		3	2	9%
8	1	5%		2	4	18%
7	1	5%		1	10	45%
6	0	0%		0	1	5%
5	1	5%				
				Total	**22**	**100%**

In the past, have you ever worked as a CQL apprentice?		
	Freq.	**%**
No	18	82%
Yes - for one year	0	0%
Yes - for two years	2	9%
Yes - for three years		
Yes - for four years	2	9%
Total	**22**	**100%**

Do you serve as a mentor for apprentices or students in programs other than CQL?		
	Freq.	**%**
No	11	50%
Yes	11	50%
Total	**22**	**100%**

Do you serve as a mentor for apprentices or students in programs other than CQL? (n = 11 responding mentors)						
Program	**Freq.**	**%**		**Program**	**Freq.**	**%**
ORISE	5	45%		SMART	1	9%
SEAP	2	18%		USMA AIAD	1	9%
STEP	1	9%		"A program with Hood College"	1	9%
ORAU	1	9%		"Aberdeen High School Science and Math Academy"	1	9%
				Total # of programs listed	**8**	

Note. % = percentage of responding mentors who mentioned each program.

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

In which laboratory are you working?						
CQL Site	**Freq.**	**%**		**CQL Site**	**Freq.**	**%**
AMRDEC; Redstone Arsenal, AL	0	0%		**USACEHR; Fort Detrick, MD**	0	0%
ARL-A; Adelphi, MD	5	23%		**USACIL; Fort Gillem, GA**	2	9%
ARL-APG; Aberdeen, MD	10	45%		**USAMRICD; Aberdeen, MD**	0	0%
ECBC; Edgewood, MD	0	0%		**USAMRIID; Fort Detrick, MD**	2	9%
ERDC-CERL; Champaign, IL	0	0%		**Walter Reed (WRAIR); Silver Spring, MD**	1	5%
ERDC-MS; Vicksburg, MS	1	5%		**Other (specify):**	1	5%
NATICK; Natick, MA	0	0%				
				Total	**22**	**100%**

Note. Other = "Naval Medical Research Center, NMRC, Silver Spring, MD".

Which of the following best describes you?		
	Freq.	**%**
Male	14	67%
Female	6	29%
Choose not to report	1	5%
Total	**21**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	2	10%
Black or African American	2	10%
Hispanic or Latino	1	5%
White/Caucasian	12	57%
Some other ethnicity/race:	1	5%
Choose not to report	3	14%
Total	**21**	**100%**

Note. Other = "Mixed American Indian and Caucasian".

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories best describes your research field?		
	Freq.	**%**
Engineering	9	43%
Environmental Science	0	0%
Physical Science	3	14%
Chemistry	3	14%
Life Science	1	5%
Medicine / Health	1	5%
Mathematics / Computer Science	2	10%
Social Science	0	0%
Other STEM Field	2	10%
A field unrelated to STEM	0	0%
Total	**21**	**100%**

Note. Other = "Interdisciplinary (Biomechanics)", and "microbiology infectious diseases".

Please take a moment to think about your CQL mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I frequently worked with my CQL apprentice(s) in the laboratory	0 (0%)	0 (0%)	2 (9%)	5 (23%)	10 (45%)	5 (23%)	22	**4.82**	0.91
I taught my CQL apprentice(s) about performing STEM research	1 (5%)	0 (0%)	0 (0%)	4 (18%)	9 (41%)	8 (36%)	22	**5.00**	1.15
I encouraged my CQL apprentice(s) to perform a variety of tasks in the laboratory	0 (0%)	0 (0%)	0 (0%)	5 (23%)	8 (36%)	9 (41%)	22	**5.18**	0.80
I helped my CQL apprentice(s) formulate their educational goals	1 (5%)	0 (0%)	7 (32%)	6 (27%)	8 (36%)	0 (0%)	22	**3.91**	1.06
I taught my CQL apprentice(s) how to work more effectively in a laboratory	0 (0%)	0 (0%)	0 (0%)	9 (41%)	8 (36%)	5 (23%)	22	**4.82**	0.80
I spoke with my CQL apprentice(s) about their career interests	1 (5%)	0 (0%)	1 (5%)	7 (32%)	8 (36%)	5 (23%)	22	**4.64**	1.18
I helped my CQL apprentice(s) be better writers of scientific research	0 (0%)	1 (5%)	1 (5%)	5 (23%)	10 (45%)	5 (23%)	22	**4.77**	1.02
I would like to work with my CQL apprentice(s) again	0 (0%)	0 (0%)	0 (0%)	3 (14%)	9 (41%)	10 (45%)	22	**5.32**	0.72

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Use the scale provided to tell us how much you agree or disagree with each of the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I helped my CQL apprentice(s) clarify their educational goals and pathways	1 (5%)	0 (0%)	5 (24%)	8 (38%)	6 (29%)	1 (5%)	21	**4.00**	1.10
I provided guidance to my CQL apprentice(s) about the steps they will need to achieve their professional and educational goals	1 (5%)	1 (5%)	0 (0%)	13 (62%)	4 (19%)	2 (10%)	21	**4.14**	1.11
I helped my CQL apprentice(s) draft their CV/Résumé	4 (20%)	9 (45%)	4 (20%)	2 (10%)	1 (5%)	0 (0%)	20	**2.35**	1.09
I will write or help my CQL apprentice(s) obtain letters of reference	1 (5%)	0 (0%)	0 (0%)	2 (10%)	11 (52%)	7 (33%)	21	**5.05**	1.12
I introduced my CQL apprentice(s) to professional and educational networks that will help them in the future	1 (5%)	2 (10%)	2 (10%)	10 (48%)	4 (19%)	2 (10%)	21	**3.95**	1.24
I exposed my CQL apprentice(s) to professional organizations that can help them pursue their career/educational goals	2 (10%)	2 (10%)	7 (33%)	4 (19%)	5 (24%)	1 (5%)	21	**3.52**	1.36
My CQL apprentice(s) were interested in pursuing AEOP programs in the future	0 (0%)	1 (5%)	3 (16%)	6 (32%)	8 (42%)	1 (5%)	19	**4.26**	0.99
I am interested in mentoring more CQL apprentices in the future	0 (0%)	0 (0%)	1 (5%)	3 (14%)	10 (48%)	7 (33%)	21	**5.10**	0.83
I would recommend my CQL apprentice(s) for future Army internships	0 (0%)	0 (0%)	0 (0%)	2 (10%)	9 (43%)	10 (48%)	21	**5.38**	0.67

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any CQL mentor activities related to educating your apprentice(s) about STEM-related careers. Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I educated my CQL apprentice(s) about a wide variety of STEM jobs/careers.	2 (10%)	1 (5%)	4 (19%)	9 (43%)	5 (24%)	0 (0%)	21	**3.67**	1.20
I educated my CQL apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	1 (5%)	3 (15%)	3 (15%)	7 (35%)	6 (30%)	0 (0%)	20	**3.70**	1.22
During CQL, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	1 (5%)	1 (5%)	3 (15%)	6 (30%)	9 (45%)	0 (0%)	20	**4.05**	1.15
My CQL apprentice(s) expressed a lot of interest about pursuing a STEM career	0 (0%)	0 (0%)	0 (0%)	7 (33%)	11 (52%)	3 (14%)	21	**4.81**	0.68
My CQL apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	0 (0%)	1 (5%)	4 (20%)	10 (50%)	4 (20%)	1 (5%)	20	**4.00**	0.92
My CQL apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	0 (0%)	1 (5%)	0 (0%)	7 (33%)	9 (43%)	4 (19%)	21	**4.71**	0.96

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please describe the ways in which you educated your CQL apprentice(s) about STEM-related careers, especially those within the Army or DoD? (n = 13)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Academic Research Activities in CQL		**9**	
	Exposing apprentices to the research projects conducted by the lab.	5	• "I introduced him to some basic research projects being conducted in ERDC."
	Informing apprentice(s) about research conducted by DoD organizations	4	• "I informed my apprentices about the Directorates within ARL and their corresponding research focuses." • "…Discussed similar work being done by other DoD labs."
STEM Pathway		**9**	
	Guidance for apprentice(s) pathway to an Army career	5	• "Discussed the application process and the opportunities for Army physicians."
	Guidance for apprentice (s) educational path	2	• "Discussed applying to medical school and best ways to improve application."
	Introduction to working scientists	2	• "I fostered collaboration between my student and our resident experts whenever possible."
Other – Did not educate apprentice about STEM careers		**1**	• "I did not."

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please describe any challenges you faced when educating your CQL apprentice(s) about STEM-related careers, especially those within the Army / DoD? (n = 9)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Other		**5**	
	Government's fiscal climate is a challenge	2	• **"**CQL apprentices have gotten the impression that DoD careers are not stable/long term options." • **"**With all the hiring freezes and turmoil, it is hard to paint a rosy picture of working for the army."
	Time is a limiting factor	2	• "There is only so much you can do in a 2 1/2 month time frame and do a real, focused research effort." • The primary challenge was overcoming delays in obtaining full non-escort and computer access badges, which took over one month.
	Not applicable	1	• "Not applicable."
STEM Pathway		**3**	
	Mentors awareness of Army / DoD careers	2	• "I don't know 100% of everything that goes on across ARL, but that's why the summer intern tours are useful - to help the students see what's happening at ARL outside their individual projects."
	Mentor not given information to distribute	1	• "I don't remember getting any specific STEM-related career information that could be passed on to the apprentice (booklets, etc.)."

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please describe how CQL could better support you in your efforts to educate your CQL apprentice(s) about STEM-related careers, especially those within the Army / DoD? (n = 10)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Other		**6**	
	CQL is already successful	3	• "CQL has done a fine job. I can't think of any other ways."
	Involve Navy and Air Force	1	• "[CQL] could become even more dynamic if this program would be more directed as a joint military program instead of just ARMY; the Navy and Air Force would broaden this program and include more options for the apprentices."
	Better cooperation from coordinators	1	• "Also, the coordinator who is overseeing this program at WRAIR along with her upline supervisors do not listen to the mentors with suggestions about the program such as having the final presentations at Uniformed Services University instead of Georgetown. Having the elite medical researchers at Walter Reed involved in the final presentation would bring more encouragement to the apprentices to pursue careers in the fields of science."
	Streamline processing of students	1	• "Any improvement or streamlining of inprocessing would be a great improvement. This improvement would minimize the time that the apprentices wait for approval on forms, input into personnel databases, etc., and maximize the time that they are able to get into the lab and get their hands on real research."
STEM Pathway		**5**	
	Provide more information to apprentices	4	• "Upon arriving, each apprentice should receive a folder of information describing STEM opportunities within the DOD." • "Set up a website that relates career goals, education required and Army/DOD locations."
	Informed mentors	1	• "As an individual scientist, I know careers related to my field but I am not as knowledgeable of careers outside my area."
Hands-on / Laboratory Research		**1**	
	Post Baccalaureate training	1	• "Allowing apprentices to participate for a term beyond when they have stopped taking classes allows them "real" work experience and builds character/responsibility."

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any CQL mentor activities related to educating your apprentice(s) about programs offered by the Army Education Outreach Program (AEOP). Use the scale provided to tell us how much you agree or disagree with the following statements:

	1	2	3	4	5	6	n	Avg.	SD
I know about the Junior Science & Humanities Symposium (JSHS): The national science competition offered by the AEOP	8 (42%)	7 (37%)	1 (5%)	0 (0%)	2 (11%)	1 (5%)	19	**2.16**	1.54
I know about the other High School Internship programs offered by the AEOP: The Research in Engineering Apprenticeship Program **(REAP)** & the High School Apprenticeship Program **(HSAP)**	7 (37%)	7 (37%)	1 (5%)	4 (21%)	0 (0%)	0 (0%)	19	**2.11**	1.15
I know about the College Internship programs offered by the AEOP: The Undergraduate Research Apprenticeship Program **(URAP)**	7 (37%)	8 (42%)	0 (0%)	4 (21%)	0 (0%)	0 (0%)	19	**2.05**	1.13
I provided information to my apprentice(s) about one or more AEOP program(s)	7 (37%)	7 (37%)	0 (0%)	3 (16%)	0 (0%)	2 (11%)	19	**2.37**	1.64
My apprentice(s) expressed interest in pursuing AEOP programs in the future	2 (11%)	6 (32%)	2 (11%)	6 (32%)	2 (11%)	1 (5%)	19	**3.16**	1.42
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	7 (37%)	9 (47%)	0 (0%)	1 (5%)	0 (0%)	2 (11%)	19	**2.16**	1.54
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	1 (5%)	0 (0%)	1 (5%)	2 (11%)	10 (53%)	5 (26%)	19	**4.84**	1.21
I am interested in mentoring more CQL apprentices in the future	0 (0%)	0 (0%)	1 (5%)	3 (16%)	7 (37%)	8 (42%)	19	**5.16**	0.90
I would recommend my CQL apprentice(s) for future Army internships	0 (0%)	0 (0%)	0 (0%)	3 (16%)	8 (42%)	8 (42%)	19	**5.26**	0.73

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = *"Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please describe the ways in which you educated your CQL apprentice(s) about AEOP programs: (n = 7)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP Awareness		**7**	
	Discussed the SMART scholarship program	4	• "I am familiar with the SMART program and provided information to the apprentice."
	Not familiar with AEOP programs	3	• "I'm not familiar with other AEOP programs besides CQL"
AEOP Awareness		**4**	
	Mentor had limited information about AEOP	4	• "I am not aware of all the programs." • "I had no other information about programs other than SMART." • "I honestly don't have a lot of information about the programs for undergraduate or High School level students."
Other		**1**	
	Website issues	1	• "The website was down, when it came time for [apprentices] to apply."

Please describe how CQL could better support you in your efforts to educate your CQL apprentice(s) about AEOP programs: (n = 4)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP Awareness		**3**	
	Provide mentors with information to distribute	2	• "Provide booklets and materials about the other programs in the welcome packet for the apprentice." • "Create an arrival packet with this information."
	Educate mentors	1	• "Educate mentors on other [AEOP] programs."
Other		**1**	
	Tell mentors to educate apprentices about AEOP	1	• "If I was supposed to educate my apprentice about AEOP programs, this was not made apparent to me."

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please rate [your apprentice]'s laboratory skill level. (Avg. = 4.81, SD = 0.75)		
	Freq.	**%**
(1): Student is confused about the lab equipment and cannot use it effectively or safely.	0	0%
(2): Can identify the equipment and components. Knows about equipment care and safety but cannot consistently perform operations	0	0%
(3): Can perform rudimentary operations with equipment under supervision. Periodically violates proper safety and equipment care protocols	0	0%
(4): Can execute basic operations independently. Still needs periodic supervision for safety and equipment care	8	38%
(5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision	9	43%
(6): Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed	4	19%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (62%)**; 1&2 = **0 (0%).**

Please rate your apprentice's level of skill with the Data Collection Techniques (e.g., Lab, Research, and/or Measurement Techniques) that are used in your laboratory. (Avg. = 4.71, SD = 0.72)		
	Freq.	**%**
(1): Student is confused about techniques, how to perform them, and their importance. Training from a supervisor is needed regularly	0	0%
(2): Is beginning to understand techniques and their importance with supervision. Results are not useful at this point	0	0%
(3): Understands techniques and their importance but supervision is needed to perform them. Results are only useful when operations have been supervised heavily	0	0%
(4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor	9	43%
(5): Understands and uses techniques competently without supervision. Yielded results are useful	9	43%
(6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques	3	14%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (57%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories most accurately describes your apprentice's scientific teamwork/collaboration abilities in your laboratory? (Avg. = 5.14, SD = 0.57)		
	Freq.	**%**
(1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions	0	0%
(2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates	0	0%
(3): Attempts but rarely offers unique ideas to the team or manages to retain information from teammates. Occasionally late with task completion. Congenial but sometimes indifferent toward teammates	0	0%
(4): Occasionally articulates alternative ideas to the team but struggles to synthesize multiple points of view. Is usually on time with task completion. Is polite and positive with teammates	2	10%
(5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates	14	67%
(6): Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole	5	24%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **19 (90%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's scientific reasoning skills/abilities? (Avg. = 4.71, SD = 0.56)		
	Freq.	**%**
(1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles	0	0%
(2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles	0	0%
(3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles	0	0%
(4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles	7	33%
(5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research	13	62%
(6): Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research	1	5%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **14 (67%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories most accurately describes your apprentice's information literacy skills/abilities? (Avg. = 4.95, SD = 0.74)		
	Freq.	**%**
(1): Information searches are not connected to research needs and search is done entirely via web search engines. No information from sources is included nor consideration for sources	0	0%
(2): Information searches are vaguely tied to research needs and search is not systematic in nature. Sources are often not credible, plagiarism is evident, and ethical uses are not considered	0	0%
(3): Sometimes does not discern needed information and how or where to search for it. Sources are sometimes not credible and ethical uses of information are compromised occasionally	0	0%
(4): Has a rudimentary understanding of needed information and how or where to search for it. Finds mostly credible sources and understands that plagiarism is unacceptable	6	29%
(5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses	10	48%
(6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner	5	24%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **15 (71%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's quantitative literacy skills/abilities? (Avg. = 4.85, SD = 0.67)		
	Freq.	**%**
(1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation	0	0%
(2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation	0	0%
(3): Sometimes misunderstands quantitative information which results in inaccurate sets of findings. Judgments are occasionally not based on results and may not consider some limitations	0	0%
(4): Converts quantitative information into results but they are occasionally inaccurate. Judgments and conclusions are based on results but sometimes incomplete while consideration for limitations may also be incomplete during derivation	6	30%
(5): Adequately converts and interprets quantitative information into an accurate set of results. Applies the results of analysis to judgments and conclusions while considering assumptions and limitations in their derivation	11	55%
(6): Expertly converts and interprets quantitative information into a comprehensive set of accurate results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation	3	15%
Total	**20**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **14 (70%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories best describes your apprentice's Introduction/Purpose? (Avg. = 5.29, SD = 0.61)		
	Freq.	**%**
(1): The student provides no real purpose and makes little to no connection with existing research	0	0%
(2): The purpose of the research evades the student. Connections with existing research are often inaccurate or misinterpreted	0	0%
(3): Only partially understands the purpose of the research. Connections with existing research are sometimes inaccurate	0	0%
(4): The purpose of the research is accurate but sometimes unclear. Connections with existing research are incomplete	1	7%
(5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague	8	57%
(6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research	5	36%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (93%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Methods (e.g., description of equipment & procedures)? (Avg. = 5.50, SD = 0.65)		
	Freq.	**%**
(1): The student provides no list or description of the equipment or procedures for this study	0	0%
(2): Equipment and procedures are inaccurately listed and described. Replication would be impossible	0	0%
(3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult	0	0%
(4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information	1	7%
(5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification	5	36%
(6): Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report	8	57%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (93%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories best describes your apprentice's Results (e.g., data analysis, interpretation & findings) (Avg. = 5.36, SD = 0.63)		
	Freq.	**%**
(1): Does not report or analyze data. Interpretation of findings is non-existent or not based on the provided evidence	0	0%
(2): Analyzes data incorrectly. Interpretation of results is inaccurate.	0	0%
(3): Misunderstands some data analyses and makes several mistakes. Makes some errors interpreting results. No synthesis of findings	0	0%
(4): Understands data analysis but makes one or two mistakes. Only rudimentary interpretation of results. Synthesis of findings is incomplete	1	7%
(5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear	7	50%
(6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts	6	43%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (93%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Conclusions? (Avg. = 5.14, SD = 0.53)		
	Freq.	**%**
(1): No conclusions, limitations, or future directions are offered	0	0%
(2): Discussion of findings is unstructured and does not tie back to the research question very well. Barely touches on limitations	0	0%
(3): Vaguely ties the findings back to the research questions. Limitations are only touched on. No future directions are offered	0	0%
(4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed	1	7%
(5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus	10	71%
(6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research	3	21%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (93%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories best describes your apprentice's Structure? (Avg. = 5.25, SD = 0.45)		
	Freq.	**%**
(1): Does not include or distinguish between an abstract, body, appendix, or bibliography	0	0%
(2): Missing two or more components (abstract, body, appendix, or bibliography). Ordering, labeling, and grammar are not acceptable	0	0%
(3): Missing one component (abstract, body, appendix, or bibliography). Order of sections is disjointed or mislabeled. Grammar is minimally acceptable	0	0%
(4): Abstract, body, appendices, citations, and bibliography are included with mistakes. Order and labeling of sections is present but not always clear. Grammar is adequate	0	0%
(5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality	9	75%
(6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable	3	25%
Total	**12**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (100%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Oral Communication? (Avg. = 5.46, SD = 0.66)		
	Freq.	**%**
(1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)	0	0%
(2): Fails to present one intro, purpose, and/or conclusion. Very few and non-credible supporting materials are used	0	0%
(3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best	0	0%
(4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question	1	8%
(5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility	5	38%
(6): Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility	7	54%
Total	**13**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (92%)**; 1&2 = **0 (0%).**

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Do you have any other comments or input to provide us regarding your apprentice(s)' final research project? (n = 10)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Academic Research Activities		**5**	
	Exceeded expectations	3	• "[My apprentice's] novel work warrants publication in a peer-reviewed journal. It will advance testing methods for the field." • "I was impressed with what [my apprentice] accomplished. Due to scheduling, he often had to work independently without immediate supervision. That did not prevent him from working through project." • "[My apprentice] went way above my expectations and proved to be a great asset to our research project."
	Pleased with project	2	• "He did a good job on a challenging project in a relatively short amount of time." • "Very pleased with [my apprentice's] work."
Other		**5**	
	Final project is not yet complete	5	• "Not yet complete. Will complete this week." • "[My apprentice] is currently collecting data but has completed her report based upon pilot data. She will give a presentation to team members of her actual findings on Aug 21 and will update her results, discussion, and conclusion sections to reflect her new data."

Do you have any other comments or input to provide us regarding your CQL apprentice? (n = 6)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Satisfaction		**5**	
	Positive experiences with apprentice	4	• "Very motivated, hardworking, smart, and nice to be around." • "[My apprentice] is a true pleasure to work with…"
	Would recommend for future positions	1	• "I highly recommend him for future internships or even a position after he graduates."
Academic Research Activities		**2**	
	Excellence in research	2	• "[My apprentice] is smart, capable, inventive, can work independently and eager to achieve and produce results" • "Her sense of integrity, duty, and commitment demonstrates maturity well beyond her age."
Hands-on Research Activities		**1**	
	Excellence in applied skills	1	• "His skills in Computer Aided Design software and the visual programming language Labview proved invaluable."

Appendix C:
2013 CQL Mentor Questionnaire, Rubrics, and Data Summary

Please take a moment to tell us about any successes and/or challenges that you or your apprentice(s) experienced during CQL this year? (n = 8)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Satisfaction with program		**11**	
	Access to computers and software is a consistent challenge	5	• "My apprentices' experienced greater than expected delay in being able to access their computers." • "One of my apprentices was able to recover from a severe delay in having a specific software installed on their computer." • "It took about 6 weeks to get the needed access to a computer, the network drives, and the internet. That's over half of the internship."
	Stipend payments were a consistent challenge	4	• "…there was insufficient communication from CQL to the apprentices regarding timing and frequency of pay." • "Getting [my apprentice] paid has been quite a challenge…In June, checks arrived rather than direct deposit. [My apprentice's] check was over $300 less than it should have been - a mistake that is still being sorted out here at the beginning of August." • "It was not made clear to either the mentor or the apprentice how funding would be distributed…For example, my apprentice received a travel stipend, but I was unable to find anyone in the program who could tell me when or how that stipend would be disbursed."
	Program scheduling	1	• "Apprenticeship runs from 6/10-8/23. Initial rounds of summer intern presentations were July 18, 5 weeks into [the apprenticeship], just when he was starting to get experimental results. I'm not sure when other interns start and leave, but it seems likely that most of them don't have much done by the middle of July."
	Would recommend apprentice for future positions	1	• "I would have hired him full time if I could."
Academic Research Activities		**4**	
	Apprentice was successfully trained as a researcher	4	• "This apprentice took the initiative to approach the problem a different way, resulting in their greater understanding of the problem and its accompanying theory." • "[My apprentice's] project has been a success; he met his goals in every way." • "He has taken a lot of initiative to look up and study facial recognition algorithm"
STEM ambassadorship		**1**	

	Apprentice sharing knowledge with others	1	• "He worked well with others and provided some training to existing employees in some of the techniques."

Appendix D:
2013 CQL Apprentice Focus Group Protocol

Introductory questions:

1. Can we see a show of hands, who has participated in AEOP programs: [list]
    - Junior Solar Sprint
    - Junior Science and Humanities Symposium
    - West Point Bridge Design Competition
    - eCYBERMISSION
    - summer programs (GEMS/UNITE)
    - apprenticeship programs (REAP, SEAP/CQL, HSAP/URAP)
    - scholarship programs (SMART/NDSEG)

2. Why did you choose to participate in CQL this year?
    - How did you learn about the program?
    - How did you "get connected" with your mentor?

Key questions:

3. Think of a typical day in CQL and tell me about the mentoring you received?
    - What did your mentor do to support you?
    - What kind(s) of feedback did you get from your mentor?

Previous students have reported these things, have any of you experienced these? Reviews lab notebooks, chalk talks, group meetings, one-on-one demonstration/coaching?

4. What is the most valuable aspect of participating in CQL?
    - What specific ways has it benefited you?
    - What does REAP offer that you don't get at school/college?

5. Are you interested in STEM jobs/careers offered by the Army and Department of Defense agencies? Why or why not?
    - What impact did your mentor have on your future career aspirations/pathway?

6. Are you interested in becoming a mentor yourself? Why/why not?

Ending questions:

7. If you had one minute to talk to an Army decision maker about CQL, what would you say?
8. Have we missed anything? Tell us anything you want us to know that we didn't ask about.

Appendix E:
2013 CQL Mentor Focus Group Protocol

Introductory questions:

1. Can we see a show of hands, who has mentored in AEOP programs before: [list]
    - Junior Solar Sprint
    - Junior Science and Humanities Symposium
    - West Point Bridge Design Competition
    - eCYBERMISSION
    - summer programs (GEMS/UNITE)
    - apprenticeship programs (REAP, SEAP/CQL, HSAP/URAP)
    - scholarship programs (SMART/NDSEG)

2. Why did you choose to participate in CQL this year?
    - How did you learn about the program?
    - How did you "get connected" with your apprentice?

Key questions:

3. Think of a typical day in CQL and tell me about the mentoring you provided?
    - What did you do to support your apprentice?
    - What kind(s) of feedback did you give to your apprentice?

4. What do you perceive as the value of the CQL?
    - How have you benefited from participating?
    - How do you think apprentices benefit from participating?

5. How did you educate your apprentice about AEOP initiatives?
    [If no response, share brochures with mentors]

6. How did you educate your apprentice about STEM jobs/careers offered by the Army and Department of Defense agencies?
    - What resources do you need to educate apprentices about STEM careers at Army/DoD agencies?

7. What impact do you think you had on your apprentice's future STEM education/career aspirations?

Ending questions:

8. If you had one minute to talk to a Army decision maker about CQL, what would you say?
9. Have we missed anything? Tell us anything you want us to know that we didn't ask about.