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Supplemental Material

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High-Flying Interns: NASA's Student Airborne Research Program (SARP)

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College/University Name	MSI	Carnegie Basic Classification*
Adelphi University	AANAPISI	D/PU
Agnes Scott College		BC
Alaska Pacific University	NASNTI	BC
Allegheny College		BC
Amherst College		BC
Appalachian State University		MC
Arizona State University	HSI	R1
Auburn University		R1
Augsburg College		MC
Augustana College		MC
Barnard College		BC
Baylor University		R1
Beloit College		BC
Berea College		BC
Boise State University		R2
Bowdoin College		BC
Bridgewater State University		MC
Brigham Young University		R2
Brown University		R1
Butler University		MC
California Baptist University	HSI	MC
California State Long Beach	HSI	D/PU
California State Polytechnic University, San Luis Obispo		MC
California State University of Northridge	HSI	MC
California State University San Bernardino	HIS	MC
Carleton College		BC
Case Western Reserve University		R1
Centre College		BC
Chapman University		R2
Coast Guard Academy		BC
Coastal Carolina University		MC
Coe College		BC
Colgate University		BC
College of Saint Benedict and Saint John's University		BC
College of Staten Island CUNY		MC

College of William and Mary		R1
Colorado College		BC
Colorado School of Mines		R2
Columbia University		R1
Concord University		MC
Cornell University		R1
Creighton University		R2
	AANAPISI &	
	HSI	
CUNY City College of New York		R2
Dartmouth College		R1
Davidson College		BC
DePauw University		BC
Dominican University of California		MC
Embry Riddle Aeronautical University		BC
Emory University		R1
Florida Gulf Coast University		D/PU
Florida State University		R1
Fordham University		R2
George Mason University		R1
Georgia Institute of Technology		R1
Gonzaga University		D/PU
Gustavus Adolphus College		BC
Harvard University		R1
Harvey Mudd College		BC
Henderson State University		MC
Hendrix College		BC
Hobart and William Smith Colleges		BC
Hood College		MC
Howard University	HBCU	R2
Humboldt State University	HSI	MC
Indiana University		R1
Iowa State University		R1
James Madison University		R2
Johns Hopkins University		R1
King University		MC
Knox College		BC
Lawrence University		BC
Lewis University		MC
Loyola Marymount University		R2
Loyola University Chicago		R2

Lyndon State College/Northern Vermont University		MC
Macalester College		BC
Massachusetts Institute of Technology		R1
Michigan State University		R1
Michigan Technological University		R2
Millersville University		MC
Mills College	HSI	MC
Minnesota State University Mankato		MC
Mississippi State University		R1
Missouri University of Science and Technology		R2
Montana State University		R1
Montclair State University	HSI	R2
Mount Holyoke College		BC
Muhlenberg College		BC
Murray State University		MC
New Mexico State University	HIS	R2
North Carolina State University		R1
North Central College		MC
North Park University		MC
Northern Arizona University		R2
Northern Kentucky University		D/PU
Norwich University		MC
Ohio State University		R1
Ohio University		R2
Oklahoma State University		R1
Old Dominion University		R1
Oregon Institute of Technology		BC
Oregon State University		R1
	AANAPISI &	
Pacific Union College	HSI	BC
Pennsylvania State University		R1
Pepperdine University		D/PU
Piedmont University		MC
Pitzer College		BC
Plymouth State University		MC
Pomona College		BC
Portland State University	AANAPISI	R2
Prairie View A&M University	HBCU	R2
Principia College		BC
Providence College		MC

Purdue University		R1
Randolph College		BC
Rensselaer Polytechnic Institute		R2
Rice University		R1
Ripon College		BC
	AANAPISI &	
Rutgers University	HSI	R1
Saint Mary's University of Minnesota		D/PU
San Jose State University	HSI	MC
Scripps College		BC
Seattle University		D/PU
Seton Hall University		R2
Slippery Rock University		MC
Smith College		BC
South Dakota School of Mines and Technology		MC
Southeast Missouri State University		MC
Southeast University		D/PU
Southern Nazarene University		MC
Spelman College	HBCU	BC
St. John's University		D/PU
St. Olaf College		BC
Stanford University		R1
State University of New York College at Plattsburgh		MC
State University of New York Stony Brook		R1
Stephen F. Austin State University		MC
Swarthmore College		BC
Temple University		R1
Texas A&M Corpus Christi	HSI	R2
Texas A&M University		R1
The College of Idaho		BC
The College of Wooster		BC
Towson University		MC
Trinity International University		BC
Tufts University		R1
Tulane University		R1
Tuskegee University	HBCU	MC
University of Alabama in Huntsville		R2
University of Alaska Anchorage		MC
University of Alaska Fairbanks	AANH	R2
University of Albany -SUNY		R1

University of Arizona	HSI	R1
University of California Berkeley		R1
University of California Davis	AANAPISI	R1
	AANAPISI &	
University of California Irvine	HSI	R1
University of California Los Angeles		R1
	AANAPISI &	
University of California Merced	HSI	R2
	AANAPISI &	
University of California Riverside	HSI	R1
University of California San Diego		R1
University of California Santa Barbara	HSI	R1
University of California Santa Cruz	HSI	R1
University of Chicago		R1
University of Cincinnati		R1
University of Colorado Boulder		R1
University of Colorado Colorado Springs		R2
University of Connecticut		R1
University of Delaware		R1
University of Denver		R1
University of Florida		R1
University of Georgia		R1
University of Hawaii at Manoa	ANNH	R1
	AANAPISI &	
University of Houston	HSI	R1
University of Illinois at Urbana-Champaign		R1
	AANAPISI &	
University of Illinois Chicago	HSI	R1
University of Iowa		R1
University of Kansas		R1
University of Kentucky		R1
University of Louisiana at Monroe		D/PU
University of Maine		R2
University of Maryland, Baltimore County	AANAPISI	R2
University of Maryland, College Park		R1
University of Massachusetts Amherst		R1
University of Miami		R1
University of Michigan		R1
University of Michigan Dearborn		MC
University of Minnesota		R1
University of Missouri		R1

University of Nebraska - Lincoln		R1
University of Nevada, Las Vegas	AANAPISI & HSI	R1
University of New Hampshire		R1
University of New Mexico	HSI	R1
University of New Orleans		R2
University of North Carolina at Charlotte		R2
University of North Carolina at Wilmington		R2
University of North Dakota		R2
University of North Florida		R2
University of Northern Colorado		D/PU
University of Northern Iowa		MC
University of Notre Dame		R1
University of Oregon		R1
University of Pennsylvania		R1
University of Pittsburgh		R1
University of Puerto Rico	HSI	R2
University of Redlands		MC
University of Richmond		BC
University of Rochester		R1
University of South Alabama		R2
University of South Carolina		R1
University of St. Thomas		BC
University of Tennessee at Martin		MC
University of Texas Rio Grande Valley	HSI	R2
University of Tulsa		R2
University of Utah		R1
University of Vermont		R2
University of Virginia		R1
University of Washington	AANAPISI	R1
University of West Florida		MC
University of Wisconsin, Madison		R1
University of Wisconsin, Milwaukee		R1
University of Wyoming		R2
Upper Iowa University		MC
Utah State University		R1
Valparaiso University		D/PU
Vanderbilt University		R1
Virginia Polytechnic Institute and State University	AANAPISI	R1
Washington State University		R1
Washington University		R1

Wellesley College		BC
Wesleyan University		BC
West Virginia University		R1
Western Illinois University		MC
Western Kentucky University		D/PU
Western New Mexico University	AANAPISI	MC
Western Washington University		MC
Westmont College		BC
Worcester Polytechnic Intitute		R1
Yale University		R1

***MSI type definitions represented in SARP**

AANAPISI = Asian American Native American Pacific Islander - Serving Institutions

ANNH = Alaska Native and Native Hawaiian Serving Institutions

HBCU = Historically Black Colleges and Universities

HSI = Hispanic Serving Institutions

NASNST = Native American-Serving Nontribeal Institutions

****Classifications from: <https://carnegieclassifications.iu.edu/lookup/lookup.php>**

R1: Doctoral Universities – Very high research activity

R2: Doctoral Universities – High research activity

D/PU: Doctoral/Professional Universities

MC: Master's Colleges and Universities

BC: Baccalaureate Colleges

Supplemental Table 1: The 238 colleges and universities that have been represented in SARP 2009-2021 are listed along with a column indicating the Minority Serving Institution (MSI) type of that institution (if any). More than 17% of colleges and universities that have been represented in SARP are MSIs. Only 14% of total US institutions are considered MSIs (<https://www.nap.edu/read/25257/chapter/5>). Also included is the Carnegie Basic Research Classification of each school (<https://carnegieclassifications.iu.edu/lookup/lookup.php>). SARP participants come from a variety of university types with 62% coming from non-R1 universities.

Year	Aircraft	Instrument	Measurement Description	Data Volume/Points	
2009	NASA DC-8	University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	20382*	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	6.36 GB	
2010	NASA DC-8	AVOCET: LI-COR 6252	CO ₂	39000	
		PICARRO 2301 Gas Concentration Analyzer	CH ₄ , CO ₂ , H ₂ O	25380	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	15114*	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	17.26 GB	
2011	NASA DC-8	University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	20868	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	11.50 GB	
2012	NASA P-3B	AVOCET: LI-COR 6252	CO ₂	49413	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples*	27784*	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	6.92 GB	
2013	NASA DC-8	AVOCET: LI-COR 6252	CO ₂	33793	
		Ultra-High Sensitivity Aerosol Spectrometry	Aerosol Size Distribution	47677	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	23947*	
		University of Houston Trace Gas Suite	CO, NO, NO ₂ , O ₃	34013	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	13.61 GB	
2014	NASA DC-8	Ultra-High Sensitivity Aerosol Spectrometry	Aerosol Size Distribution	558877	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	19422*	
		University of Houston Trace Gas Suite	CO, O ₃	53683	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	12.40 GB	
2015	NASA DC-8	AVOCET: LI-COR 6252	CO ₂	51926	
		2B-Tech Ozone	O ₃	51926	
		PICARRO	CH ₄ , CO	57507	
		Ultra-High Sensitivity Aerosol Spectrometry	Aerosol Size Distribution	465160	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	28308*	
		University of Houston Trace Gas Suite	CO, O ₃	9323	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	15.43 GB	
		AVOCET: LI-COR 6252	CO ₂	38230	
2016	NASA DC-8	California Institute of Technology CIT-ToF-CIMS	H ₂ O ₂ , HAC, HCN, HNO ₃ , PAA, and others	687774	
		Georgia Institute of Technology - Chemical Ionization Mass Spectrometry	PAN, PPN, APAN, PBZN; SO ₂ , HCl	38716	
		NASA Ames airborne sunphotometer	AOD	76274	
		NASA Langley Aerosol Research Group	aerosol microphysical/optical properties and cloud droplet microphysical properties	38575	
		NASA Langley Diode Laser Hygrometer	H ₂ O	38232	
		NCAR 4-Channel Chemiluminescence Instrument	NO, NOy, NO ₂ , O ₃	37286	
		NCAR CAFS (CCD-based Actinic Flux Spectrometers)	Photolysis frequencies of many species	26734	
		NOAA HDSP2	Black Carbon	1166	
		Pennsylvania State University ATHOS	OH, HO ₂	1245	
		University of California - Berkeley laser induced fluorescence	LIF of nitrogen dioxide	37872	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	38675*	
		University of Colorado CLH2 Total Water	Condensed Water Concentration	38037	
		University of Colorado HR-TOF AMS	Chemically speciated submicron non-refractory particulate mass	3236	
		University of Colorado - INSTAAR - CAMS Spectrometer	C ₂ H ₆ , CH ₂ O	65683	
		University of New Hampshire Mist Chamber Ion Chromatography	Nitric acid and fine aerosol sulfate	553	
		University of Oslo PTR-TOF-MS	non-methane hydrocarbons	38088	
		ER-2	AVIRIS	Imaging Spectrometer	14.4 GB
			MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	10.04 GB
		2017	C-23*	CAFE - Formaldehyde	CH ₂ O
	NASA Goddard Greenhouse Gas Suite - Los Gatos Research			CO ₂ , CH ₄ , H ₂ O	44276
University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples			34556*	
NASA Langley B-200*	GEOTASO		NO ₂	1.6 GB	
	AVIRIS		Imaging Spectrometer	108.0 GB	
NASA ER-2	MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	4.73 GB		
2018	NASA DC-8	CAFE - Formaldehyde	CH ₂ O	40833	
		CANOE - Nitrogen Dioxide	NO ₂	31946	
		NASA Langley Diode Laser Hygrometer	H ₂ O	44240	
		PICARRO	CO, CO ₂ , CH ₄	16712	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	32966*	
	NASA ER-2	AVIRIS	Imaging Spectrometer	23.3 GB	
		MODIS/ASTER (MASTER) Airborne Simulator	Multi-Spectral Imaging	5.83 GB	
2019	NASA DC-8	NASA Goddard CANOE	NO ₂	40625	
		NASA Langley Aerosol Research Group	Aerosol microphysical/optical properties and cloud droplet microphysical properties	115317	
		NASA Langley Diode Laser Hygrometer	H ₂ O	38055	
		NASA Langley DIAL/HSRL	Imagery of Troposphere O ₃ , Aerosols, and Clouds Profiles	N/A	
		NOAA AOP	Measurements of bulk aerosol extinction and absorption	38541	
		NOAA CIMS	N ₂ O ₅ , C ₂ H ₄ O ₃ S, HNCO, HCOOH, HCN, ClNO ₂ , Cl ₂ , CH ₃ COOCl, BrO, BrCN, BrCl	416636	
		NOAA ERSL Ozone-induced chemiluminescence	NO, NOy, O ₃	114117	
		University of California - Irvine Whole Air Samples	Hydro/Halo Carbon Grab Samples	38016*	
		University of Colorado HR-TOF AMS	Chemically speciated submicron non-refractory particulate mass	23346	
		University of Colorado - INSTAAR - CAMS Spectrometer	C ₂ H ₆ , CH ₂ O	31212	
		University of New Hampshire Mist Chamber Ion Chromatography	Nitric acid and fine aerosol sulfate	250	
Dynamic Aviation B-200	AVIRIS-Next Generation	Imaging Spectrometer	156 GB		

*Number of air canisters collected multiplied by number of gases measured per canister

Supplemental Table 2: Details of Summer SARP instruments flown, measurements made by each instrument, and samples taken/data volume.

	Overarching	Subordinate	Type	Summary of Responses
1	Time Allocations	Allocation among different elements of the Program such as lectures, field measurements, data analysis, etc.)	Rating scale	Available in chart format
		Comments on any of the time allocations discussed above	Free Response	A variety of comments were provided on the time allocated to different program activities such as, SARP 2019 student: I think the time allocation was good for most of the talks but it was just a lot of information to be thrown at us over the first week. I think spreading these lectures out some, or even just slowing them down would be helpful.

2	Relevance	Did the classroom lectures in Palmdale help prepare you for the flights? (Comment generously, since a simple yes/no does not convey advice for how to improve the program.)	Free Response	The lectures were very informative and provided a general background to what was being studied; there was an overwhelming amount of information. SARP 2018 student: Yes, it really helped a great bit. As exhausted as I was throughout them, they were useful.
		Did the program expose you to research practices beyond those advanced students might experience at your university?	Free Response	Yes, research opportunities such as those presented in the Program do not typically occur at the institutions from which majority of the SARP students come from. SARP 2012 student: I come from a small college with limited research opportunities and no atmospheric chemistry program. This was exactly what I needed to confirm my interest in atmospheric chemistry and gain valuable research experience that I

				need when applying for graduate school.
		Was your involvement with the instruments and their operation onboard the aircraft	Rating scale	Available in chart format

		Comments on instrument integration/operation	Free Response	Depending on the assigned research group, some students felt that they had more opportunity than others, on the flights for hands-on instrument operation. Students also gained a lot by working closely with experimenters on the aircraft and learning more about the measurements made. SARP 2018 student: It was a nice to be able to just go up to anyone who's instrument we were interested in and just learn about it from them in this informal setting.
		Rate your knowledge of NASA's role in the Earth System Sciences BEFORE SARP	Rating scale	Available in chart format
		Rate your knowledge of NASA's role in the Earth System Sciences AFTER SARP	Rating scale	Available in chart format

		Rate your knowledge of the NASA Airborne Science Program BEFORE you attended SARP	Rating scale	Available in chart format
		Rate your knowledge of the NASA Airborne Science Program AFTER you attended SARP	Rating scale	Available in chart format
3	Student Selection	How did you learn about the program?	Free Response	Responses include: From a Professor/Advisor; SARP Alum; Internet search; NASA Internship website
		Was the application procedure clear and appropriate?	Free Response	Yes
		What venues would alert more students to the opportunity?	Free Response	Students provided information on Campus Career Services, School internship program offices and faculty information
		Is the number of students (pick one)	Rating scale	Available in chart format
4	Research Groups	Were you satisfied with the way you were assigned to a research group?	Free Response	Majority of the students had very positive comments

		Should there be more, fewer, or the same number of research groups?	Free Response	Same number
		Were you satisfied with the field trip component of your research group?	Free Response	Yes! SARP 2016 student: I wish we could have stayed longer! But I was really thrilled with the time that we did spend out in the field.
		Did you learn from students/mentors/faculty in the other three groups?	Free Response	Yes! SARP 2019 student: Yes, I really like the interdisciplinary nature of SARP. It's so nice to learn from everyone with radically different backgrounds. It really makes you a better scientist.
		Did the individual project you worked on reach a stage of completion and value that was: Beyond what you expected? About what you expected? Unsatisfactory?	Free Response	Students responses varied, covering all levels of expectations for their individual projects. SARP 2015 student: I felt like I could have done a lot more with the amount of data that I had on my project, however I would not say that I was

				unsatisfied with the work that I did.
		Were you given adequate help learning what to do and how, but also given experience figuring out most things yourself? In other words, did you receive a true research experience?	Free Response	Majority of the students felt that they were provided with adequate help throughout the Program and received a true research experience. SARP 2017 Student: Yes, I feel like guidance was given where needed. Of course the mentors were not able to help us with everything, but we shouldn't expect them to know everything either. Part of becoming a researcher involves figuring out certain things on our own.

5	Value	Did participation in the program benefit you? If yes, in what ways? If no, why not?	Free Response	100% yes! SARP 2017 student: Definitely. I'm glad to have gained research experience and learned what I like in a research position and what I don't like. It was also great to hear the mentors grad school/life advice.
		Would you advise other students to apply to future Student Airborne Research Programs?	Free Response	100% yes!

6	Careers	Did participation in the Student Airborne Research Program influence your career plans? Plans for future education? If so, how?	Free Response	<p>Overall the responses discussed their major takeaways from the Program and how it has helped influence future decisions.</p> <p>SARP 2016 student: Yes! I didn't really realize airborne science was a field and now I'd like to continue doing this kind of research. I knew I liked field work but I'd never experienced it outside of my geology field trips. I also learned a lot from every single person involved in the program. One of the most appealing things for me when applying was the large amount of collaboration among students as well as faculty and I definitely experienced that this summer.</p> <p>Another SARP 2016 student: Participation in this program has</p>
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				<p>allowed me to develop better critical thinking skills to construct my own project and troubleshoot obstacles on the way. It prepared me to solve future problems by teaching me how to think and try different solutions. I also got an idea of how research is conducted outside of a wet lab, and also exposed me to field work and how important those measurements are. This experience has allowed me to feel more like a scientist.</p>
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7	Logistics	Feedback on the different logistical elements provided during the Program (Lodging, transportation, stipend, classroom resources, IT resources, etc.)	Rating scale	Available in chart format
		Please comment on any of the logistics above. If you had specific issues with your computer, please describe in detail what these were.	Free Response	Most of the comments were focused on the individual computers and software provided during the Program
8	Online Information	Was the NSRC SARP website/livebinder helpful?	Free Response	100% Yes! SARP 2017 student: So helpful!! I referenced back to the binder multiple times a week for papers or calendar or instrument reminders!
		Did you read the suggested references before arriving to SARP?	Free Response	Most students replied with a yes, some said not really, and skimmed the material before the Program
		Was the SARP Facebook page useful?	Free Response	About 70% of the students said yes

9	National Suborbital Research Center (NSRC)	Were the staff helpful? Did they respond to your concerns/issues in a timely manner? Was the program well-organized?	Free Response	Overwhelming positive feedback for the staff
10	Enrichment Activities	Were the tours of NASA facilities and aircraft useful/interesting? (Armstrong Flight Research Center, JPL, Caltech)	Free Response	Overwhelming positive feedback for the tours. SARP 2013 student: Yes, they were. Each one of these tours was incredible and they all made me learn something new.
11	Length	Was the length of the program adequate? too long? too short?	Free Response	A lot of the students felt that the Program was too short and would have liked more time to work on their individual research projects. SARP 2018 student: It'd be nice for the program to be longer for more time for research, even by one more week would be sufficient.
12	Mentor Evaluation	Mentor's name (please select from dropdown menu)	Multiple Choice	Available in chart format

		Feedback on the Graduate Student Mentor's involvement (Organization, subject matter knowledge, support provided, level of engagement, etc.)	Rating scale	Available in chart format
		Please use this space for any additional comments or suggestions for your mentor	Free Response	Comments for the Mentors are compiled and sent to them
		Many of you may have worked with and/or received assistance from mentor/s other than your own. Please feel free to provide comments about your experience with the other mentors here	Free Response	Comments for the Mentors are compiled and sent to them
13	Programming/Coding Mentor	Overall, how would you rate having a Programming/Coding Mentor at SARP?	Multiple Choice	Available in chart format
		Please comment about your experience working with the Coding Mentor and/or writing code for your project at SARP in general. Has coding/learning to code at SARP inspired you to use coding in your future research?	Free Response	Comments for the Coding Mentor are compiled and sent to him/her

14	Faculty	Please comment on your interactions with your SARP faculty advisor	Free Response	Comments for the Faculty are compiled and sent to them
15	Program Location	Did the location of the program in Southern California make you more or less likely to apply/accept?	Rating scale	Available in chart format
		Please comment about the program's location in Southern California	Free Response	Overwhelming positive responses for the Program being held in Southern California. Students commented on the good weather, abundance of activities, and the setting for research projects. SARP 2018 student: I really loved the location and through it provided a really cool combination of projects to study.
16	Final Comments	Please offer any suggestions for ways SARP could be improved.	Free Response	Comments covered a whole range of topics such as lodging, social interactions, lectures, transportation options, scheduling, program length etc.

		What did you like the best about the program (what shouldn't we change?)	Free Response	Comments covered a whole range of topics such as flights, social interactions, lectures, field trips, research groups etc.
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Supplemental Table 3: Overview of the final survey questions and answers that students are required to complete at the conclusion of the Program. The final evaluation is divided into 16 overarching questions which are supported by subordinate questions (rating scales, multiple choice and free response), all producing empirical and methodical findings. The complete survey results are available on request.