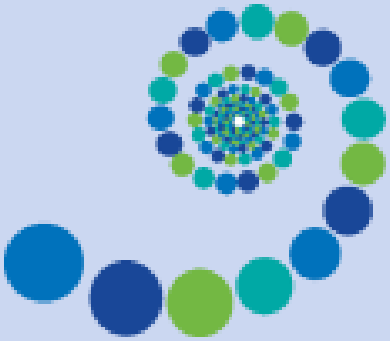

NIMBioS

Evaluation Report

SUMMER RESEARCH EXPERIENCES FOR UNDERGRADUATES AND TEACHERS

JUNE 5 – JULY 28, 2017

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2017 Projects and Participants

Mating Patterns in Birds' Evolution

Participants: Sharee Brewer (Fisk Univ.), Kimberly Dautel (Marist College), Brian Lerch (Case Western Reserve Univ.), and Alan Liang (Cornell Univ.)

Mentors: Dr. Nourridine Siewe, NIMBioS, Postdoctoral Fellow; Dr. Sarah Flanagan, NIMBioS, Postdoctoral Fellow

Some species exhibit multiple mating strategies within a single population, but the dynamics causing some individuals to exhibit polygyny (one male with several females) and others to exhibit monogamy (one male with one female) are not well understood. This project built a model representing overlapping generations in a species in which individuals can exhibit either monogamy or polygyny. The goal of the model was to understand under what conditions both mating strategies will be maintained in the population. The project parametrized the model using data from various species, including birds such as the canvasback duck.

Temporal Dynamics in Multi-Host Systems: How Important is Seasonality

Participants: Tanay Wakhare (Univ. of Maryland), David Nguyen (Eastern Washington Univ.), and Lara "Larissa" Weaver (Univ. of Tennessee)

Mentors: Dr. Nina Fefferman, Ecology and Evolutionary Biology, UTK; Dr. Kellen Myers, Research Associate, UTK

Many pathogens in nature circulate among multiple host species. Understanding which species are the drivers of observed disease dynamics is critical to both control efforts and to preserving species/ecosystem functions in the face of emerging pathogens. Even within a single ecosystem, different host species affected can exhibit very different seasonal life-history patterns: distinct mating and breeding seasons, hibernation, etc. This project used a combination of agent-based models, differential equation models, and simplified game theoretic models to consider how these different disease-independent seasonal patterns in host populations can interact with disease transmission patterns to shape pathogen circulation dynamics among hosts in the ecosystem.

Modeling the Spread of La Crosse Virus in East Tennessee

Participants: Brian Hardison (Pi Beta Phi Elementary School), Patrick Wise (Univ. of Delaware), Maitraya Ghatak (Univ. of Tennessee), and Javier Urcuyo (Arizona State Univ.)

Mentors: Dr. Suzanne Lenhart, NIMBIoS Assoc. Director for Education and Outreach; Mathematics, UTK; Dr. Rebecca Trout Fryxell, Medical and Veterinary Entomology, UTK

In North America, La Crosse encephalitis is the leading mosquito-borne disease among children and is transmitted via the bite of Aedes mosquitoes infected with La Crosse virus. The disease and its vectors are common in southern Appalachia. Using biological data (mosquito and virus collections), environmental data (precipitation and temperature), and epidemiological data (diagnosed cases) this project developed mathematical models to explain and illustrate the spread of the virus in eastern Tennessee. The project goal was to identify potentially predictive variables or features associated with increased mosquito numbers, positive mosquitoes, and human cases.

Modeling the Immune System Battleground in Host-Virus Conflict

Participants: Alison Adams (Univ. of Georgia, Athens), Quiyana Murphy (Univ. of Kentucky), and Owen Dougherty (Univ. of Tennessee)

Mentors: Dr. Colleen Jonsson, Microbiology, UTK; Dr. Christina Edholm, Mathematics, UTK

Why do certain mammalian species become ill following infection with virus while others do not? How can certain species of mammals harbor and maintain viruses over their life time without any signs of disease? There are numerous examples of the dual nature of viruses, particularly, zoonotic viruses. Zoonotic viruses such as Ebola viruses, SARS coronaviruses, and hantaviruses exist in nature in bat or rodent hosts and only when they accidentally spill over to humans do they cause disease. In general, scientists hypothesize that the disease is caused by an inability to control infection. The immune response plays a vital role in controlling infection within individual hosts. This project Modeled how viruses control infection in their natural host and those in which they cause disease provides a framework for the discovery of how viruses interact with their hosts and potential new targets for therapeutic intervention.

Developing Computer Games for Teaching Biology

Participants: Axel Hranov (Univ. of Tennessee), Audrey Hommes (Vanderbilt Univ.), and Saroj Duwal (Univ. of New Orleans)

Mentors: Dr. Susan Riechert, Ecology and Evolutionary Biology, UTK; Dr. Max Schuchard, Electrical Engineering and Computer Science, UTK

This team reconfigured physical exercises associated with the Biology in a Box Project into computer simulation games. The idea was to offer novel learning experiences that are structured as entertaining games rather than merely tutorials and exercises. For example, we chose to develop a game that utilizes our existing 3D Cambrian World populated by 22 species. Players were introduced to the evolutionary history of biodiversity through game play. They explored an ancient sea world from a first person perspective under the challenge of capturing images of the 'living' forms of fossils. The project then briefly reviewed the 11 thematic Biology in a Box units to learn what this year's team is most interested in developing a game for.

Participant Satisfaction (94% response rate)

Overall, 93% of SRE participants were satisfied

94% of participants indicated SRE met at least some expectations

81% of SRE participants felt the workload was just right

SRE Participants' comments:

"I enjoyed the NIMBioS SRE program and everyone involved. It was a great experience and I am really proud of our research project. I appreciate that the students were grouped in a way in which everyone, regardless of major or academic level, were able to be engaged and assist throughout the duration of the project. Everyone had an important role, and I highly value that.

93% of 2017 SRE Participants would recommend the program to others.

Reasons for recommending the program to others:

> **It was a fun and educational experience where I was able to perform research, make good friends in both my fellow SRE students, and the mentors I worked with. The staff at NIMBIOS is very open about helping you if you have some form of problem whether it be printing a poster or figuring out how to format a paper.**

> **We were able to do several very fun and unique outdoor experiences as well such as our trips to the Smokies. Wonderful faculty, variety of fun experiences, flexible schedule, wonderful peers**

> **If you're interested in math bio, you'll learn a lot**

> **It was a good learning experience (at least for learning Unity and other coding), and while the work demand was fairly laidback, I found myself motivated to make my project the best that I could.**

> **I met some great people and did some fun research. Therefore I couldn't have asked for a better summer.**

> **Great research program especially for undergrad students seeking to enhance resumes.**

> **It was an amazing experience and I received high quality mentoring and was able to work on an interesting research project. I also had a lot of fun hanging out in Knoxville with the other participants.**

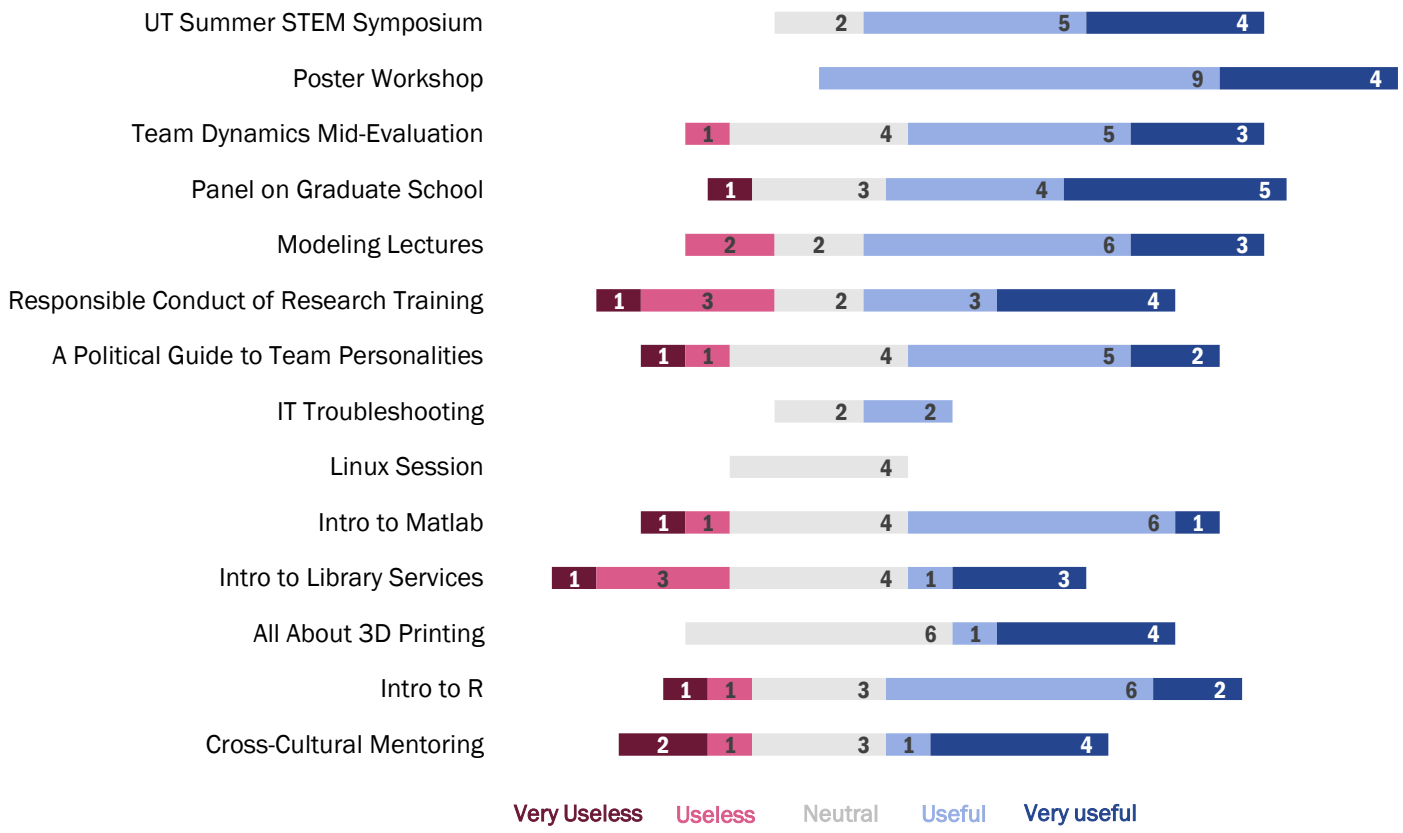
> **I would recommend the NIMBioS SRE to other students because I feel as though it is a beneficial program regardless of your major area of study. If you're a biology major you'll learn math while also being able to help those who are not as sound in biology and vice versa. The NIMBioS staff are very friendly and the mentors were great as well.**

> **Fantastic opportunity to gain research experience and work with professionals in their fields**

> **It was a great experience that exposed me to new tools and fields to which I normally do not have access. It has had an impact on my grad school plans, and I feel I will be a stronger grad applicant with the SRE under my belt and especially with the help of my mentors in crafting a strong application.**

> **Very nice introduction to math bio, in a structured environment**

Usefulness of lectures and sessions



Other lectures participants found valuable:

> Dr. Nina Fefferman gave an introductory lecture on evolutionary game theory which was helpful for my group. Oyita Udiani also talked to my group specifically about how to go about utilizing evolutionary game theory in our model which was extremely valuable for my group.

> The very first one by Lou Gross

> We were allowed to sit in on lectures during the grad student workshop in June, which led to some very interesting lectures on a variety of topics

> The ability to attend various graduate workshops that also occurred throughout the SRE were also useful.

Comments about lectures or sessions:

> They were all very useful. would have like the 3d printing one to be in the beginning.

> They were extremely helpful!

> Some lectures (especially those organized by UT) were simply off topic for our program. The modeling lectures led by Suzanne certainly helped some participants, however they were extremely basic for those participants that had previous modeling experience.

Satisfaction with accommodations

85% satisfied with housing.

88% satisfied with computing resources.

71% satisfied with extracurricular activities.

54% satisfied with mail service.
(6 neutral)

Additional accommodations/supports needed:

> **Some Information on which restaurants and places of dining are open in summer and their hours would be a bit helpful.**

Graduate School Plans

9 **out** **of** **14**

SRE Participants indicated the experience **impacted their plans for graduate school.**

Ways in which the research experience impacted plans to go to graduate school:

> **This helped me define the exact area/field I hope to work towards in graduate school.**

> **I am much more enthused to go to graduate school due to the opportunities to talk to and receive advice from graduate school students and professors.**

> **I thought I wanted to pursue an MPH and go into public health practice, but my experience at NIMBioS made me more seriously consider an MS/PhD route into disease research.**

> **It helped guide my interest into what field of study I wanted to go into. i was somewhat exposed to math modeling before this summer but now i'm a bit more confident it is something I wish to go to grad school for.**

> **Before I participated in the SRE I lacked confidence that I had the aptitude to do research and go to graduate school. The interactions I had with other participants and my ability to contribute to the project allayed those fears. My SRE mentor was instrumental in making me feel that I could go to graduate school; they welcomed me into their lab and was always available to listen and give me advice.**

> **It further solidified my plans to attend graduate school. I had an idea I wanted to go and figured I would like research but now I know that's what I want to do in the future.**

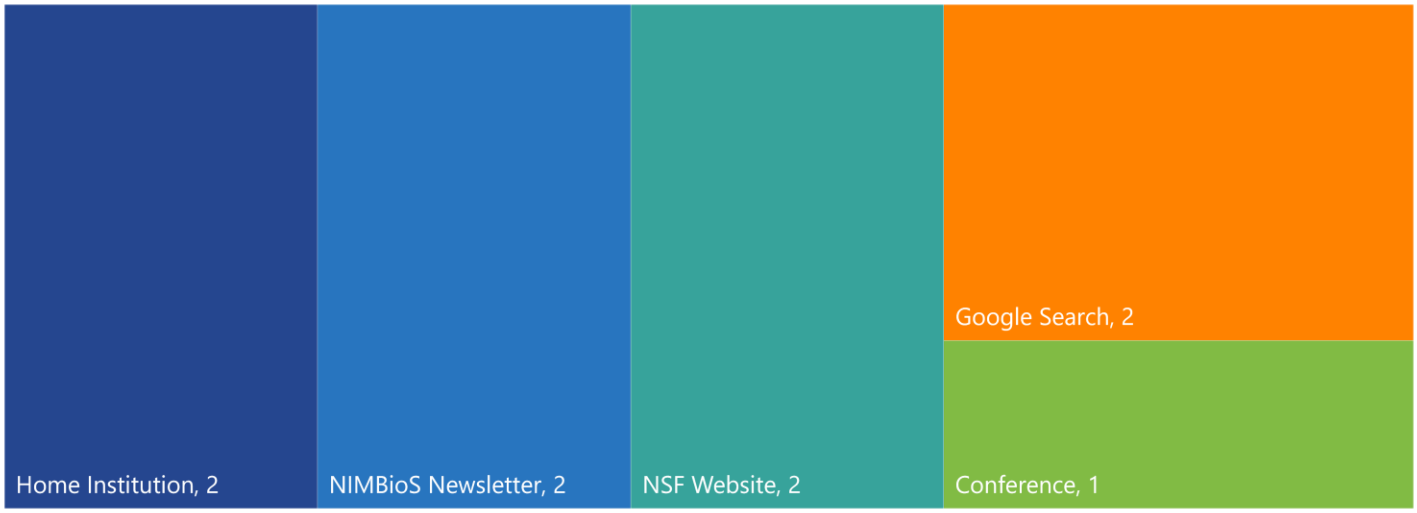
> **Not sure if research is my thing.**

Additional participant findings

10 **out** **of** **14** **SRE Participants** hope to complete a **doctoral degree.**
(Aspirations remained the same from pre to post, except for one person who changed their hopes from a Master's degree at pre-survey to doctoral at post-survey.)

3 **out** **of** **14** **SRE Participants** hope to complete a **Bachelor's degree.**

Ways in which participant learned about the program



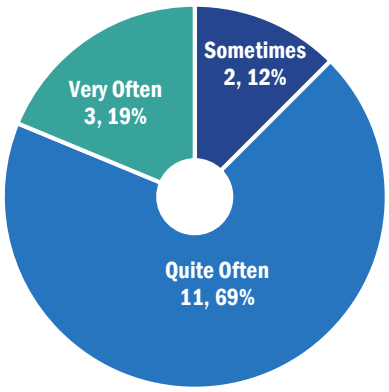
Basecamp

10 SRE students felt Basecamp was a useful means of communicating within the SRE group.

2 SRE students did not feel it was useful.

1 SRE student did not use Basecamp.

How often participants felt their groups worked well together



Facilitators of group success

- Open communication about project goals, expectations, work load, meeting times, etc.
- The teamwork session we had early on in program helped to offset potential arguments and conflicts between our team. We were also paired very well with each of us having a strength in focus and education we could bring to the table.
- Being able to meet at the NIMBioS facility provided a productive work environment
- Everyone being physically present and, if not, strong communication to ensure we all knew what to be working on; understanding each group-member's strengths and weaknesses to allow us all to focus on our strong points
- Focusing on the same task, knowing the goals we wanted to achieve in a certain amount of time
- Communication, remaining on task, and respecting and valuing everyone's opinion.
- Regularly meeting to talk about and work on our project
- We understood each other's roles, and we catered to those strengths.
- When we were communicating our ideas and thoughts as well as working together.
- The biggest key was communication. Making sure that everyone was on the same page and that we had a plan was integral to our success. The more frequently we met with one another (and our mentors), the more successful we seemed to be.
- Communication
- Open Communication -Consideration and Feedback on everyone's ideas -Compromise on conflicting concepts -Compartmentalizing work

Barriers to group success

> A primary barrier was that we divided up our tasks sometimes and completed them solo. But this left us somewhat disorganized into how to bring our work back together at first. We worked on sharing and rotation of tasks we did, and tried to have meetings more often to ensure we all on same page

> The biggest barrier was the lack of group meetings (without mentors). Additionally, when the group would work separately, sometimes multiple people worked on the same thing.

> Personal disagreements, best handled through more communication

> Lack of communication

> Confusion over who was doing what; lack of communication

> A group member playing games or watching YouTube videos when they should be working. focusing too much on a less important task instead of the most important

> When everyone had very different ideas about project direction there was a lot of confusion. Once we decided on the direction of our project, we functioned much better.

> We had major issues with communication and group dynamics that we were unable to resolve; a group member ended up leaving the project in the 7th week of the program. I'm not sure how we could have resolved the issue.

> A barrier that prevented my group from working well together was when we had different ideas. In the beginning of the SRE this was the case as our project idea was very broad and we didn't have a direction. However, this was resolved once we all came to an agreement in the direction we wanted to head into.

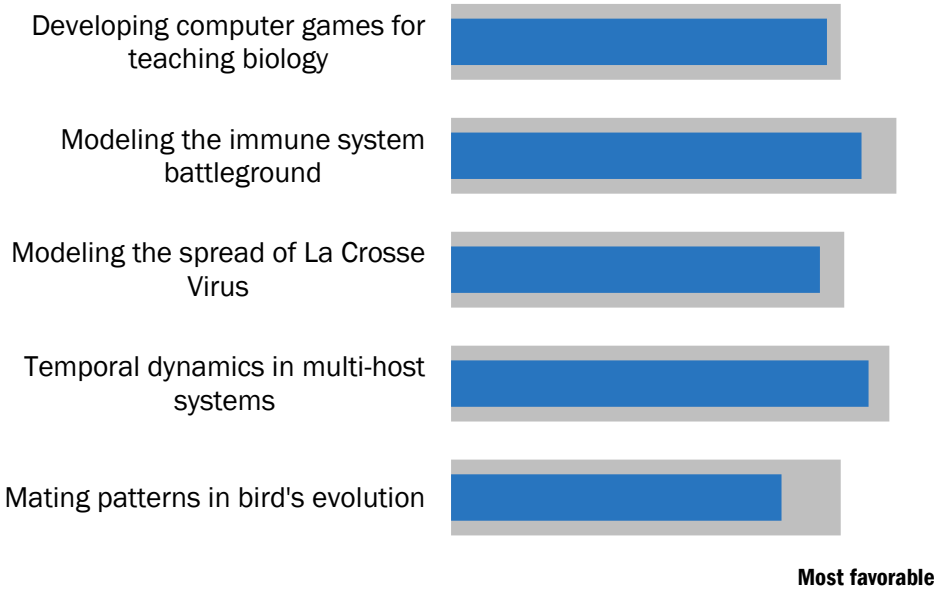
> Not being direct about what was needed or our plan led to suboptimal work efficiency. Further, if one person did their own thing for too long that could lead to confusion.

> There were none

Participant Satisfaction with Mentors

Aggregated assessment of mentors by research group

Comparison of mentor composite scores within projects. Blue bar is for mentor 1 and gray bar is for mentor 2.



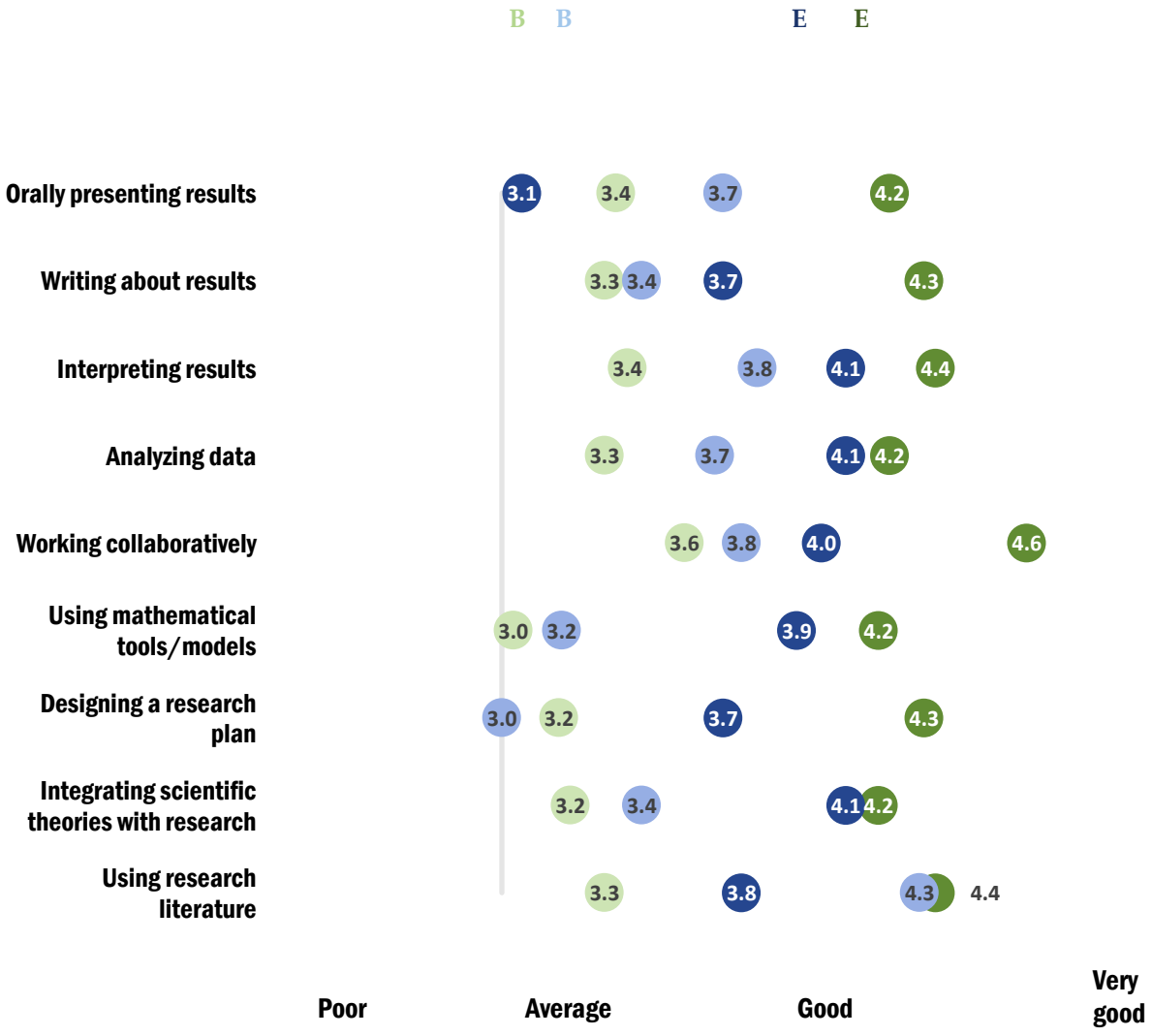
Additional comments:

> NIMBioS was a great experience and I truly appreciate all the work that is put into making the program a possibility for the participants. All the mentors and administrative staff deserve a lot of thanks, and they're doing a great job making NIMBioS a positive experience.

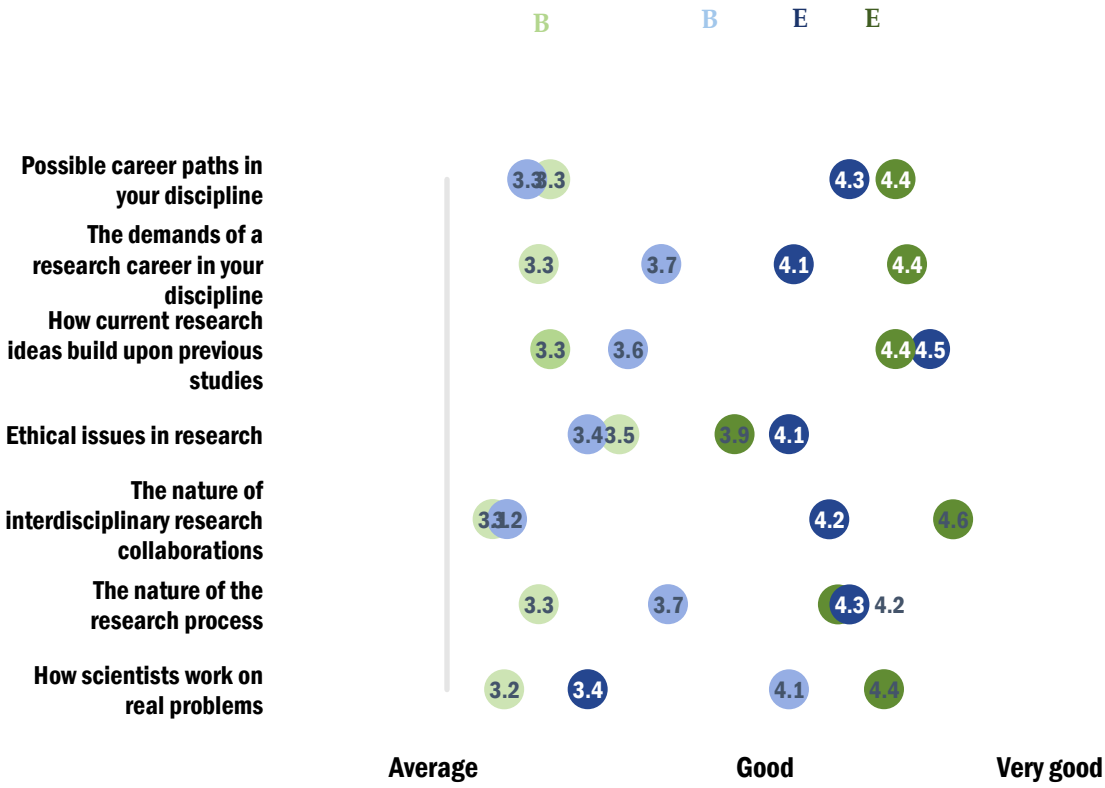
> I enjoyed the NIMBioS SRE program and everyone involved. It was a great experience and I am really proud of our research project. I appreciate that the students were grouped in a way in which everyone, regardless of major or academic level, were able to be engaged and assist throughout the duration of the project. Everyone had an important role, and I highly value that.

Program Impact

SRE participants and mentors rated research skills of SRE participants at the beginning (B) and end (E) of the program. Overall increases were evident across research skills. The decrease in SRE participants' scores for 'Orally presenting results' and 'Using research literature' may be due to an overestimation of their skills at the beginning.

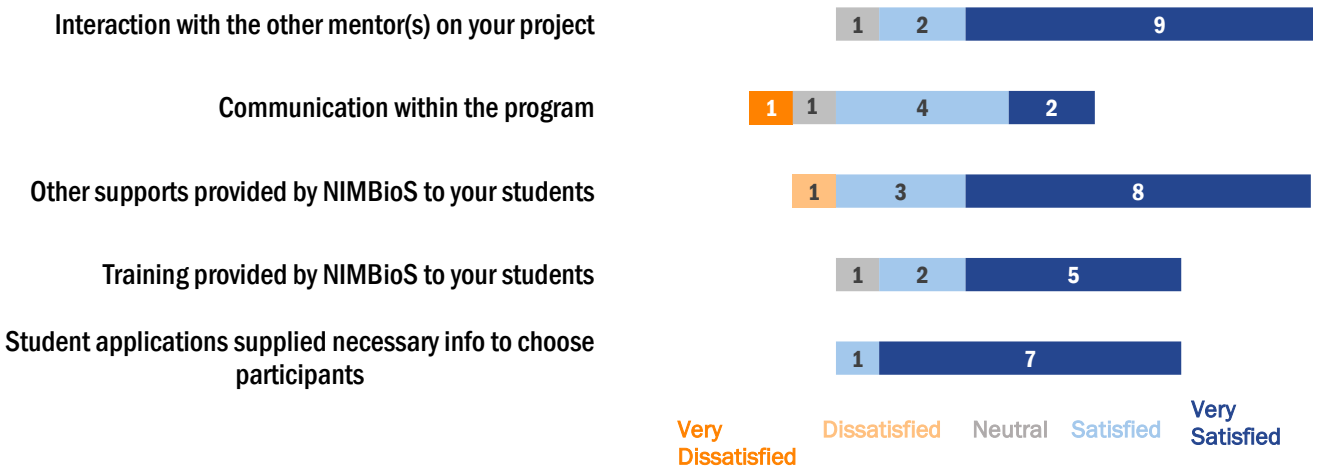


SRE participants and **mentors** rated knowledge of SRE participants about scientific careers and the research process at the beginning (B) and end (E) of the program. Overall increases were evident across knowledge areas. The decrease in SRE participants' scores for 'How scientists work on real problems' may be due to an overestimation of their knowledge at the beginning.



Mentor Satisfaction (80% response rate)

Project mentors responded to several questions regarding satisfaction with various program activities.



100% of 2017 SRE Mentors were satisfied with the NIMBioS SRE program.

Additional comments or suggestions for improving the program next year:

> With respect to the review of the student, I suggest adding another bullet that allows one to choose "insufficient ability to determine".

> The program is fine. This questionnaire does not fit the computer game team well. All three of our applicants worked very hard on the project and were enthusiastic participants. I know that two of the three gained improved tool kits from working on the project. It was harder for me to judge with the third person, as he was extremely quiet. His fellow teammates, however, assured me that he was fully engaged and contributing.