The Tennessee Governor’s School for Scientific Models and Data Analysis

Sunday, May 25th through Friday, June 27th, 2014

Annual Report to the Governor and the People of the State of Tennessee

Dr. Jack Rhoton, Director
Angela Haga, Assistant Director

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Created, Edited and Prepared by:
Ms. Angela Haga
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Tennessee Governor's School for Scientific Models and Data Analysis Program Summary and Evaluation for 2014

I. **The People**: Leadership Team, Faculty and Staff, Counselors and Students

A. Leadership team: The year-round work of preparation for the 2014 Tennessee Governor’s School for Scientific Models and Data Analysis was carried out by the director, Dr. Jack Rhoton, and the assistant director Ms. Angela Haga.

B. Faculty and staff: The for-credit faculty consisted of two (2) full-time East Tennessee State University faculty members: one from the Department of Mathematics, one from the Department of Biology. The faculty and staff biographies are in *Appendix A*.

C. Counselors: Five East Tennessee State University students served as resident counselors. Since they have more contact with the Scholars than any other staff member, the counselors are a crucial part of the GSSM&DA program. Each of the four (4) counselors was responsible for 4.285 scholars with one counselor acting as a resident “counselor at large”. The biographies of the counselors are in *Appendix B*.

D. Students: The thirty (30) Scholars who attended represented fifteen (15) Tennessee counties. There were twenty-one (21) females and nine (9) males. Nineteen (19) of the students were rising seniors and eleven (11) were rising juniors. A statistical breakdown of the student body, including the counties from which the Scholars came, may be found in *Appendix C*.

II. **The Program**: Courses, Seminars and More

A. Academic courses: There were two (2) academic courses offered, one at 9:15am-12:00 noon and one in the afternoon 1:15-3:00pm. The curriculum was designed to expose the Scholars to a rich selection of mathematics and science courses consisting of general biology, symbiosis, and probability and statistics; descriptions of all of the courses are in *Appendix D*. The average for the group for *BIO 1110-011 course* was (15 A's at 50.0%; 10 A-'s at 33.0 %; 3 B+’s at 10.0%; 2 B's at 6.4%. The average for the group for *MATH 1530-014 course* was (7 A's at 23.3%; 13 A-'s at 43.3%; 3 B+’s at 10%; 5 B's at 17.0%; 1 B-'s at 3.3% and 1 C+ at 3.3%.

B. Plenary sessions: The plenary sessions consisted of Dr. Rhoton, Ms. Haga, the resident counselors, and the GS scholars. The sessions started at 9:00am and were completed by 9:30am. The sessions were on Tuesday’s of the five (5) week period.

C. GS Scientific Models & Data Analysis Web site: Ms. Haga is in charge of the website and is updating it periodically with pertinent information regarding the 2014 Governor’s School and the upcoming 2015 Governor’s School.
III. The Rest of the Experience: Culture, Fun, and Competition Embedded in Science

A. Scholars had the opportunity to participate in the following field trips: The Gray Fossil Site in Gray, TN; Snap-On Tools in Kingsport, TN; ETSU Medical School Labs in Johnson City, TN; Historic Jonesborough in Jonesborough, TN; Roan Mountain State Park in Roan Mountain, TN; Aerojet Rocketdyne in Jonesborough, TN; Bays Mountain State Park in Kingsport, TN; Eastman Chemical Company in Kingsport, TN; Wetlands Water Park in Jonesborough, TN and the Carter Family Fold and Museum in Hiltons, VA.

B. The staff worked hard to create a learning community, putting students together with each other as well as with the staff and GS Scientific Models & Data Analysis faculty in informal settings such as project group meetings, open time, activities with counselors, and the plenary meetings.

C. The food services provider, ARAMARK, prepared meals while scholars were on campus (breakfast, lunch, dinner). The opening and closing banquets also contributed a sense of formality and accomplishment to the program; Scholars had the opportunity to speak at the closing banquet which was held at the Millennium Centre Ballroom here in Johnson City.

D. An ice cream and cake party celebrating the Scholar birthdays falling within the School provided a brief escape from the students’ studies.

E. A memory “Yearbook” featuring pictures taken throughout the Governor’s School program created by Ms. Haga and was given to all of the Scholars and counselors for a keepsake at the closing luncheon.

F. Ms. Haga also compiled the photos that were taken during the five (5) week Governor’s School program into a “Movie” w/music that was shown during the closing ceremonies and she will incorporate the photos (movie) onto a DVD that will be mailed to all the graduating scholars and counselors at a later date.

IV. The Results: Scholar Evaluations

The Scholars’ satisfaction with the 2014 GS Scientific Models & Data Analysis program is reflected in the overall rating of the program, with 93.75 percent of the Scholars rating the program as either "excellent" (5) "very good” (4) or “good” (3) a cumulative rating of 4.80 out of 5. Evaluations of various aspects of the program were rated as follows:

A. Overall Program: 3.00 / 5  
B. Academic component/workload: 3.00 / 5  
C. Faculty/courses: 4.00 / 5  
D. Counselors: 5.00/ 5  
E. On-Campus meals: 5.00 / 5  
F. Dormitory Lodging: 4.00 / 5

Student Evaluation comment results are attached as Appendix E. Virtually all of the Scholars wrote specific responses to the “overall feedback” question on the evaluation. A complete, unedited text of those comments is attached, with the numerical specifics, as Appendix F.
V. **The Strengths: Four Keys to Successful Outcomes**

A. A dedicated, talented, and interested faculty and staff who enjoyed working with these gifted and talented rising juniors and seniors.

B. Highly motivated students. **All thirty (30) Scholars’ who began the program completed it.** Each of those thirty (30) earned the full seven (7) hours of credit.

C. The successful class for *Scientific Models and Data Analysis* was a for-credit program, which included academic and interpersonal/social components. A full 93.75 percent of the students thought the balance of activities were “Excellent”, “Very Good,” or “Good” and the university courses offered were carefully selected as likely to “count” as part of the general education requirements at virtually any institution the students might later attend.

D. The work of the director Dr. Jack Rhoton, the instructors, professors, counselors and, especially, the GS Scientific Models & Data Analysis assistant director Angela Haga.

VI. **Conclusion**

This **2014 Governor’s School for Scientific Models and Data Analysis** program was highly successful. We had a challenging curriculum, an enthusiastic faculty and staff, and a gifted and talented group of Scholars. The Governor’s Schools are among Tennessee’s best investments, and the entire Scientific Models and Data Analysis team is already looking forward to an even better program in 2015.
APPENDIX A

2014 Faculty and Staff Bios
The Tennessee Governor's School for Scientific Models and Data Analysis

Primary Instructors

Dr. Karl Joplin
Karl Joplin is an Associate Professor in the department of Biological Sciences, College of Arts and Sciences at East Tennessee State University (ETSU). He received his BS from the University of Washington, his MS in Entomology and his Ph.D. in the Molecular. Cellular and Developmental Biology program at the Ohio State University. He did postdoctoral research at OSU before joining the faculty at ETSU. Karl’s undergraduate instructional experience is at a primarily undergraduate institution and includes 1) non-majors biology, 2) General Biology for Majors I and II, 3) General Entomology, 4) Recombinant DNA Laboratory, 5) Evolution, and 6) Honors Great Ideas in Science. His research interests involve Molecular and Physiological Aspects of Diapause in insects, Respiratory Physiology during insect development, and developmental and environmental effects on insect behavior. He has chaired 7 MS projects. He is currently the program director of a HHMI grant SYMBIOSIS: An Introductory Integrated Mathematics and Biology Curriculum. This is a three semester introductory level course that gives the students credit for biology, statistics and calculus.

Dr. Nicole Lewis
Nicole is an Assistant Professor of the Department of Mathematics and Statistics, College of Arts and Sciences at East Tennessee State University (ETSU). She received her BS degree in Mathematics from ETSU and her MS degree in Statistics from the University of Tennessee. She received her Ph.D. degree in Statistics from the University of South Carolina. Lewis' undergraduate instructional experience is at a primarily undergraduate institution, and includes 1) Probability and Statistics – Noncalculus, 2) Applications of Statistics. In addition, she has offered graduate courses in Applied Multivariate Statistical Analysis. Her research interests are in applied statistics and proteomics. She has experience in Latex, Minitab, R, and SAS.
Support Faculty and Staff

Several ETSU math and science faculty as well as other resource individuals provided special learning sessions that enhanced and enriched the classroom studies. All of the ETSU faculty provided “experimental design” sessions in which they shared their research and the experimental design they used to carry out the research. These sessions provided excellence background information for students as they designed and carried out their own research projects. The students also experienced an array of off-campus trips ranging from studies at the Gray Fossil Site to the SNAP-ON-Tools Laboratories. The individuals who led these sessions are also included. A brief bio for each of these individuals is provided below.

![Image of Jennifer Bauer]

**Mrs. Jennifer Bauer**

Ms. Bauer was born in Baltimore, Maryland. She relocated to beautiful East Tennessee not long after graduating from high school. She soon became immersed in the beauty and the biology of the S. Appalachian Mountains and found herself wanting to learn all she could about this very diverse environment. East Tennessee State University is her alma mater, three times over, completing a Bachelors Degree in Biology and Art, followed by an MS in Science Education, and an MA in Teaching. Writing soon became a passion and she has now authored 4 books; *A Naturalists’ Teaching Manual; Roan Mountain: A Passage of Time 1st and 2nd Editions; and Wildlife, Wildflowers, and Wild Activities-Exploring S. Appalachia*. Jennifer is also a frequent contributor to the Tennessee Conservationist magazine. She is employed as a Park Manager at Sycamore Shoals State Historic Area in Elizabethton, beginning her career in the role of Park Interpretive Specialist at Roan Mountain State Park for 21 years prior to promotion. Of the utmost importance to her in her professional and personal life, is becoming a good environmental and cultural educator, coupled to a strong belief in the importance of conservation and preservation. She is in her 4th year of serving on the board of directors of the Elizabethton/Carter County Chamber of Commerce. The first weekend of May, each year, she directs and organizes the Roan Mountain Spring Naturalists Rally, 2009 being its 51st year. In her “spare” time, she finds herself weaving, learning the banjo, watercolor painting, clogging, and being outdoors as much as possible. Most importantly, she loves to spend as much time as possible with her two daughters, a 2 year old granddaughter, and her husband. She may be contacted at 423-543-5808 or jennifer.bauer@state.tn.us.

![Image of Sherry Morelock]

**Mrs. Sherry Morelock**

Mrs. Morelock is the contact person for the Eastman Chemical Company-Eastman Laboratories in Kingsport, TN. She had a vital role in arranging our field trip to the Eastman Laboratories. Sherry scheduled our visit to the Biotech Lab, the Polymer Synthesis Lab, and the Physical Testing Lab. She also arranged the bridge building contest, and lunch at the Eastman visitor center.
Dr. Gary Henson
Dr. Henson has been involved in astronomy research and education for over 25 years. As a research astronomer, he has studied Variable Stars using observatories in New Mexico, Arizona, Oregon, and at ETSU. As an educator he has taught not only at the university level, but has contributed much to public outreach programs throughout his career. He currently serves as the director of both the ETSU Harry D. Powell Observatory and ETSU Planetarium and received the 2004 Distinguished Faculty Award for Service at ETSU. Dr. Henson is the Assistant Professor, ETSU Faculty since 1989, B.S. - University of Central Arkansas, M.S. - University of New Mexico, Ph.D. - University of Oregon (1989). Professional Interests: Visible & infrared photometry and polarimetry of variable stars. He may be contacted at 423-439-6906 or hensong@etsu.edu.

Mr. Fred Hilton
Mr. Hilton is the Department Supervisor for the Nature Interpretive Services Department at Bays Mountain State Park in Kingsport, TN. He was responsible for arranging our tour and scheduling the viewing of the wolves and raptors habitats, he also arranged for the GS students to attend the Nature Program and viewing the area fauna and flora.

Dr. Thomas (T.J.) Jones
Dr. Jones is currently working in the biological sciences department at East Tennessee State University and specialized in Behavioral Ecology, Neuroethology, and Science Education. In 1990 Dr. Jones received his B.S. in Biology from the Cleveland State University, and in 1993, he received his M.S. in Biology. In 2000, Dr. Jones received his Ph.D. in Evolution, Ecology, and Evolutionary Biology from the Ohio State University. Dr. Jones has a broad-based research program in the areas of animal behavior, ecology, population genetics, and neuroethology. Specifically, he is interested in the evolution of cooperation, sociality and dispersal strategies. He may be contacted at 423-439-6930 or jonestc@etsu.edu.
Dr. Debra Knisley

Dr. Knisley is an Associate Professor in the department of Mathematical and Statistical Sciences, College of Arts and Sciences at East Tennessee State University. She received her B.S. in Secondary Education/Mathematics in 1976 from the Tennessee Technological University, her M.S. in Mathematics in 1979 from the University of Memphis, and her Ph.D. in Mathematics in 1989 from the University of Memphis. Dr. Knisley has previously worked with the James H. Quillen College of Medicine in Johnson City, TN as an NSF Sponsored Visiting Researcher- in the Department of Molecular Biology and Biochemistry (2005-2006), the University of Memphis in Memphis, TN as an Adjunct Professor in the Department of Mathematical Sciences (1988-1989 while completing her dissertation), the Tennessee Technological University in Cookeville, TN as an Instructor in the Department of Mathematics (1985-1988), and at the University of Memphis in Memphis, TN as a Graduate Teaching Assistant (1982-1985). She may be contacted at 423-439-6975 or knisleyd@etsu.edu; http://faculty.etsu.edu/knisleyd/

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Dr. Hugh Miller

Dr. Miller earned his bachelor degree in Microbiology from ETSU in 1979. In 1986 he earned a Ph. D. in biochemistry from the University of Tennessee at Knoxville. After a postdoctoral fellowship at the Medical University of South Carolina, he joined the faculty of the Biological Sciences Department in 1988. While at ETSU, Dr. Miller has mentored several undergraduates and graduate students. In addition, he has been involved with curriculum issues by serving on both the College and University Curriculum committees. During academic year 2005/2006, he served the department of Biological Sciences in the capacity of Interim Chair. Recently, he has been involved in several funded educational grants including the NSF funded ATE grant, NSF funded Talent Expansion in Quantitative Biology, and the HHMI funded Symbiosis grant. Also, he serves the department one of two undergraduate advisors. During the Governor’s School, Dr. Miller was responsible for organizing and running the laboratory component of the Symbiosis course. He may be contacted at 423-439-6922 or millerh@etsu.edu.

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Dr. Diane R. Nelson

Dr. Nelson is Professor Emerita of Biological Sciences at East Tennessee State University, having retired in May 2003 after 35 years of service. In 1993, she received the ETSU Distinguished Faculty Award, the university’s highest award for combined achievements in teaching, research, and service. In April 2000 she was selected by the
Association of Southeastern Biologists as the recipient of the Meritorious Teaching Award, the society’s most prestigious award. Although she “officially” retired from ETSU, she continues to conduct research, teach workshops, and provide service to her profession. She teaches Marine Biology occasionally at ETSU and gives programs for the Johnson City Hands-On Museum as well as for numerous civic organizations, churches, and public schools in the Tri-Cities area. She is also Curator of Invertebrates and Science Education Consultant for the ETSU and General Shale Brick Natural History Museum at the Gray Fossil Site. She may be contacted at nelson@etsu.edu.

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**Dr. Jack Rhoton**

Dr. Jack Rhoton has dedicated nearly 20 years at East Tennessee State University, building a nationally recognized professional development program for science education, K-16. Prior to joining ETSU in 1987, Rhoton had 15 years of experience in public school settings in which he served as a high school science teacher and K-12 science supervisor. Known for his creative approaches to investigating science education issues, his work focuses on the preparation of pre-service and in-service teachers of science and mathematics. His efforts have impacted university faculty members; K-12 teachers; and elementary, middle and high school students. He has received nearly six million dollars in grant funding to support math and science education in Northeast Tennessee. A prolific science education author, he has published five books and sixty journal articles, and he has made numerous presentations at the local, state, and national levels. Further, thousands of students have been positively affected as a result of his many endeavors. Rhoton has served as president of the National Science Education Leadership Association (NSELA), Tennessee Academy of Science (TAS), and the Tennessee Science Teachers Association (TSTA). He has also served as program chair for the National Science Teachers Association (NSTA) area Conferences and as an NSTA board member, editor of a series of NSTA/NSELA publications, including the Science Educator Journal. He has received many honors, including the National Science Education Leadership Outstanding Science Education Leadership Award, National Science Teachers Association Distinguished Service Award, East Tennessee State University Distinguished Faculty Award, Tennessee Academy of Science Outstanding Science Teacher Award, and the Tennessee Science Teachers Association Distinguished Educator of the Year Award. He may be contacted at 423-439-7589 or rhotonj@etsu.edu.

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**Mitch Robinson, Ph.D.**

Dr. Robinson is the Associate Dean for Graduate Studies. He is currently Associate Dean for Graduate Studies and Professor of Biochemistry and Molecular Biology and at the James H. Quillen College of Medicine. He is a native of western North Carolina and holds a B.S. degree from the University of North Carolina at Chapel Hill and a Ph.D. from Wake Forest University. As Associate Dean, he oversees admissions, curriculum and all academic activities in the M.S. and Ph.D. graduate programs in the College of Medicine. Dr. Robinson is active in teaching a variety of subjects in both the graduate and medical curriculum including intermediary metabolism, lipid metabolism,
biochemistry and scientific ethics. He currently serves as the course director for the Medical Biochemistry course taught to all first year medical students. He may be contacted at 423-439-2028 or robinson@etsu.edu.

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**Dr. Edith Seier**

Dr. Seier is an Associate Professor of Mathematics/Statistics at East Tennessee State University. She received her Ph.D. in Statistics in 1998 from the University of Wyoming. Dr. Seier is currently teaching the following courses: Statistical Modeling, Applications of Statistics, Probability & Statistics (Algebra based), Probability & Statistics (Calculus based), and Time Series. Her areas of interest are: Kurtosis and variability, Statistical Consulting & Data Analysis, Teaching Statistics with an active learning approach, and Applications of Statistics to Biology, Public Health and Medicine. She may be contacted at 423-439-5812 or seier@etsu.edu.

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**Dr. Chih-Che Tai** has served as the assistant director of the Center of Excellence in Mathematics and Science Education and an assistant professor of science education the Department of Curriculum and Instruction at East Tennessee State University since July 2009. Dr. Tai holds a Bachelor of Science and Master of Science in Chemistry from National Taiwan University Taiwan, is a certified chemistry and physics teacher in Taiwan and holds a Ph. D. degree in Science Education from Teachers College, Columbia University.

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**Mr. Doug Taylor**

Mr. Taylor is the Assistant Dean of Admissions & Records at the James H. Quillen College of Medicine at East Tennessee State University. He oversees the day-to-day operation of Admissions and Records and has been in Admissions for many years and is not only exceptionally qualified, but also eager to offer his assistance. He may be contacted at 423-439-2033 or sacom@etsu.edu.
APPENDIX B

2014 Counselor Bios
The Tennessee Governor’s School for Scientific Models and Data Analysis

Amanda Pike- (Lead Counselor)
Amanda is a recent graduate of ETSU’s MAT program where she received her Master’s in Teaching with a concentration in biology grades 7-12. She is also a graduate of Tusculum College (2009) where she received her Bachelor’s degree in biology and a minor in chemistry. Amanda was also a collegiate athlete and played tennis all four years while attending Tusculum College. Since then, Amanda has been actively involved in local tennis camps that provide tennis lessons for kids ages 5-16. She has also been involved in continuing her education by attending various educational seminars such as STEM workshops. In her spare time, she enjoys outdoor activities, watching movies, and going to concerts.

Lydia Carr
Lydia is a current undergraduate student at East Tennessee State University where she is concentrating on majoring in English and minoring in Japanese and Fine Art. Lydia is currently an officer in the Japanese Cultural Society. She, also, ran a panel at the first ever ETSUcon. She is a former student of the Governor’s School for Scientific Models and Data Analysis and attended in 2010. In the future, Lydia would like to teach English in Japan through the JET Program. She enjoys playing video games, reading, and watching Japanese movies.
Rachel Brouillette
Rachel graduated from Science Hill High School in 2005 and attended ETSU for her undergraduate degree in Biology. In 2010 she started the Master of Arts in Teaching degree at ETSU. Rachel graduated with her Masters in 2012 and now teaches Biology at her high school alma mater. She was married last year in Jamaica and currently lives in Johnson City with her husband and their four dogs.

Joshua Holt
Josh is a current graduate student at East Tennessee State University where he is studying for his Masters of Science degree in Computer and Information Science with a concentration in Information Technology. Josh graduated from Milligan College with a double major in Mathematics and Computer Information Systems. Josh loves the sport of basketball and even played for Milligan College as an undergraduate. He also likes to play card games, video games, and likes to binge watch TV shows and movies.
### 2014 Student Demographics by Student Name

**Student Name, High School, City, & County**

<table>
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<th>Student Name</th>
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# 2014 Student Demographics by County

*County, Student Name, City, High School*

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14
APPENDIX C

2014 Statistical Summary

The Tennessee Governor’s School for Scientific Models and Data Analysis
(30 attendees / 147 applicants)

GENDER:  
FEMALES- 21/96  
MALES – 9/51

CLASS 2011-2012:  
JUNIORS- 11/92  
SENIORS- 19/55

ETHNIC BREAKDOWN:  
AFRICAN AMERICAN/BLACK- 1/4  
ASIAN - 0/1  
ASIAN-AMERICAN/PACIFIC ISLANDER- 11/44  
ASIAN/INDIAN - 0/1  
CAUCASIAN/WHITE - 16/79  
EGYPTIAN- 0/1  
MEXICAN/CHICANO - 0/4  
MIDDLE EASTERN/KURDISH - 0/1  
MULTI-RACIAL- 0/2  
PUERTO RICAN/CUBAN - 0/4  
PREFER NOT TO RESPOND- 1/1  
WHITE/EGYPTIAN- 1/1

HIGH SCHOOLS REPRESENTED: 27/84

COUNTIES REPRESENTED: 15/34  
(95 Counties in Tennessee)
ANDERSON- 1/5  
BEDFORD- 0/1  
BENTON- 0/1  
BLOUNT- 2/5  
BRADLEY- 0/1  
CAMPBELL- 0/1  
CARTER- 1/1  
COCKE- 1/1  
DAVIDSON- 0/12  
DICKSON- 0/1  
FAYETTE- 0/1  
HAMBLLEN- 0/1  
HAMILTON- 6/16  
HAWKINS- 1/2  
JEFFERSON- 1/5  
KNOX- 4/19  
MADISON- 0/2  
MAURY- 2/4  
MCMINN- 0/1  
MONTGOMERY- 0/3  
OVERTON- 0/1  
PUTNAM- 0/1  
RHEA- 1/2  
ROANE- 0/1  
ROBERTSON- 0/1  
RUTHERFORD- 3/9  
SHELBY- 3/23  
SULLIVAN - 1/1  
SUMNER- 0/3  
TIPTON- 0/1  
WARREN- 0/3  
WASHINGTON- 2/4  
WILLIAMSON- 1/11  
WILSON- 0/3
Goal and Objectives
The overarching goal of the Governor’s School in Scientific Models and Data Analysis was to broaden the student’s appreciation and knowledge of biology and mathematics through exposure to and integration of a wide range of contemporary biological and mathematical topics. In each case, model building and data analysis will played a critical role and was interwoven in a statistical and biological context. Students were engaged in the scientific method via hands-on research experiences. Resources from ETSU’s strong undergraduate science and mathematics program, research laboratories, and local schools were used to accomplish these objectives. In addition, the program made use of resources from industry, governmental agencies, and academic science establishments. Thus the school provided a series of courses, laboratories, projects, field trips, seminars, lectures, and other activities centered on mathematics, statistics, and biology. The curriculum consisted of courses BIOL-1110-1111 (4 credits, biological science for majors) and MATH 1530 (3 credits, probability and statistics), which were taught in the integrated fashion. The activities of the Governor’s School covered the approved syllabi for these courses and met the required number of contact hours, while extending the scholars’ intellect in directions not possible during a regular school year.

Course Work
We are guided by the conviction that today’s students are attracted to science and mathematics when these are seen as interconnected fields rather than as separate bodies of knowledge. Thus, thirty talented rising juniors/seniors from across the state were immersed in scientific instruction and inquiry in several interdisciplinary fields of science. These included: biology, bioinformatics, mathematics, statistics, and systems ecology. Second, connections between these fields were seen through the ubiquity of mathematical modeling, data analysis, and the need for high level computation. Last but not least, students gained a healthy respect for many disciplines and thus have a variety of career choices to consider as they get ready to enter college. In a nutshell, the students experienced a renaissance style Governor’s School that prepared them for many possible career options. Specific courses are described below:

9:30-12:00pm Course
Math 1530--Probability and Statistics-Lecture (3 hrs.)
Prerequisite(s): Two years of high school algebra. Descriptive statistics and its relevance, including probability, experimentation, measurement, sampling and survey, informal statistical inference, and hypothesis testing are included.
**1:00-3:00pm Course**

**BIOL 1110--Biology for Science Majors- Lecture I (3 hrs.)**
Core requisite: BIOL 1111. The principles of molecular and cellular biology, including metabolism and genetic inheritance. Designed for biology majors, minors, and others who plan to take upper-level courses for which this is a prerequisite. This course contains three (3) hours of lecture and two hours of lab. A common grade will be given in BIOL 1110/11.

**BIOL 1111-- Biology for Science Majors- Lab I (1 hr.)**
Core requisite(s): BIOL 1110. Laboratory exercises to gain the ability to identify and use the processes of biological science with materials corresponding to Biology for Science Majors Lecture I. This course contains one (2) two-hour lab per week. A common grade will be given in BIOL 1110/11.

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**East Tennessee State University**

**Department s of Biological Sciences and Mathematics**

Course: **IBMS 1100 SYMBIOSIS I**

- Number of credits 7- (4 for Biology, 3 for Statistics)
- Number of hours per week: 5 hours of lecture and 2 hours of lab

**Objectives:**

*To present Biology as a science that is dependent on quantitative analysis of data.* The course covers aspects of biology such as Introduction to the cell and cell growth, effects of size increase on organisms, Mendelian genetics, DNA replication and genomic content and how these characteristics can change over time by Evolutionary processes. *To introduce probability, descriptive statistics and statistical inference in the context of the study of Biology.* The course covers the typical content of an introductory statistics course plus some additional topics. The notion of statistical inference is introduced very early in the course by means of randomization tests and the exact sampling distribution of the sample proportion based on the Binomial distribution. The examples in probability are mainly oriented toward topics of interest in genetics and bio-informatics at an elementary level.

**IBMS 1100** is the first course in a 3 course sequence that integrates biology, statistics, and mathematics. As a result, the mathematics and statistics is introduced, explored, and developed in biological contexts, including surface area to volume ratios, isometric and allometric scaling, fractals in biology, and difference equations and discrete systems in genetics, evolution, and the study of DNA. Pre-calculus concepts and limits are also introduced and developed in IBMS 1100, both due to the natural contexts which arise for doing so (such as log-log plots) and because a major goal of the Symbiosis project is to spread the coverage of calculus I across 2 semesters as a way of promoting greater student success in both calculus comprehension and skill development.

**Teaching method:** Lectures were prepared mainly in power-point. Hands-on class activities and data analysis in the computer lab were used when appropriate on addition to the wet/dry lab component.
Textbook: Complete class notes, on addition to power point presentations, were written for this course by the instructors under a grant from HHMI, they are available from the D2L platform.

Statistical software: Minitab, R, Maple, Java Applications, Image J, Web-based Applets and Activities

Module 1. - The Scientific Method
The study of Biology is introduced. Aspects of what hypotheses are and how they are tested leads into statistical inference. Examples of hypothesis testing such as von Helmont’s plant growth test and Stanley Prussiner’s Prion Hypothesis are discussed. An introduction of Arbovirus infection of Yellow Fever leads to a discussion of viruses and definition of life. The hypothesis of whether AIDS can be transmitted by mosquitoes is used as an example of the use of quantitative biology. The five themes of biology are introduced as the thread of further modules.

What is Statistics? Role of statistics in the scientific method. An introduction to the role of mathematics and statistics in science in general. Randomization test to test the hypothesis of equal means (medians, variances) of two populations based on experimental data. Why do we study probability? Basic definitions: random experiment, sample space, event. Definitions of probability: classical, relative frequency, axiomatic definition and its consequences; independent events; replicates of a random experiment; Pascal triangle and basic combinatorics. Types of random variables, mass or probability function and density functions. Discrete probability distributions; binomial distribution; applying the binomial distribution to do test of hypothesis about a population proportion. First glance at the limit concept (probability as limit of a relative frequency, along with difficulties in using such a definition). First glance at mathematical models.

Module 2. - The Cell and Statistics
Introduction to the cell. What is the cell and why are they small? What is the concept of multicellularity? The organization of the cell and what are the consequences of the components functions. TANSTAAFL (There ain’t no such thing as a free lunch), a more wide ranging discussion of consequences starting from the more formally known Second Law of Thermodynamics. The transmission of information into and out of the cell. The cell cycle and mitosis as a consequence of cell growth, repair and quiescence. Data production: observational studies and experiments. Basic definitions: population, sample, individual, variables (categorical & quantitative).

Displaying and summarizing data for categorical variables, tables and graphs, relative risk, odds ratio, measuring agreement in matched-pairs situations. Displaying and summarizing data for quantitative variables, tables and graphs for one, two and several variables at the time. What are the data telling us? How to decide between the different statistical graphs? Location (mean vs. median, five number summaries) and variability statistics. Sources of variability. Looking at paired data. Correlation. What is statistical inference? Introducing the idea of sampling variability and sampling distribution. Exact sampling distribution of a sample proportion (based on the Binomial distribution) and its application to hypothesis testing and estimating with confidence. Bootstrapping to do inference about a population mean. Randomization or
permutation test to test hypotheses about a parameter (mean, median or variance) in two populations.

**Module 3.- Size and Scale**
What happens to an organism as it grows bigger? Can ants really toss locomotives off the tracks? Can King Kong jump off the Empire State Building? Can Tyrannosaurus rex really run at 80 kph? This module examines the functions that describe what happens when organisms grow (or shrink). Included are organism size as a determining factor in shape, the differences between isometry and allometry, problems with isometric scaling in biology, bacteria size, shape, organization, cell wall structure, and other characteristics. Exponential growth of bacterial populations. Biological models with mass as the independent variable. Area, volume, and surface area to volume ratio. Isometric scaling, slope, equations of lines, allometry and power laws. Limits as tools for approximation. The exponential function. Logarithms. Linear regression and transformed variables. Normal distribution. Fractal Geometry as it relates to biological organisms and the surface area to volume ratio.

**Module 4- Mendelian Genetics**
Why was Gregor Mendel able to elucidate the laws that determine how organisms pass genetic information from one generation to the next? This crucial process was discovered and then ignored for almost 40 years and yet was the key that Darwin was missing to explain Evolution. The data and processes that Mendel used to determine these principles are examined. In this context, Meiosis is described as the cellular equivalent of Mendelian Laws.

A coin model to understand genotypes and phenotypes for all combinations of homozygous and heterozygous parents. Punnet squares and probability trees, 'back-testing'. Comparing experimental results with the expected results under an assumed model: Chi-square test of goodness of fit. Review of probability basics. Chi-square test of independence. Fisher’s exact test. Test of homogeneity. Describing dependence with relative risk and odds ratio. Conditional probability and Bayes rule. Discrete distributions, expected value and variance, discrete uniform, Bernoulli, Binomial and its use to test hypotheses about a population proportion. Power of a test. Determining sample size based on the desired power for a test. Poisson distribution, binomial and normal approximations to the Poisson distribution. Introduction to sampling: population, sampling frame, sampling size, sampling methods (simple, systematic, cluster, two-stage, stratified), transect sampling, sampling and non-sampling error, capture/recapture and distance sampling.

**Module 5- DNA genetics**
Mendelian Laws describe how information is passed from generation to generation, but the molecular processes were not determined until the nature and structure of DNA was described. The structure of this molecule and the consequences of replication are covered. Is DNA the same in different organisms? Quantitative tools to look at the composition of the information are developed. DNA as nucleotide sequences, nucleotide frequency, GC content. Independence and conditional probability in the DNA environment. Transition matrix, graph to represent transition matrices. Probability of a given sequence of nucleotides, repeats of a single nucleotide, length of the repeat, geometric distribution. Palindromes, probability of any palindrome and of specific palindromes, space in between palindromes. Comparing two sequences of nucleotides. Similarities that happen just by chance. Random walks (and their use in testing for similarities). Sampling distribution of the sample mean and its use in confidence interval estimation and hypotheses testing. Approximated distribution (normal) of the sample proportion and its use in confidence interval estimation and hypotheses testing. Necessary sample size calculation in the case of estimation based on desired precision and
confidence and the case of testing hypothesis based on the desired power. The t-student
distribution and its application to inference for the sample mean.

**Module 6- Evolution**
“Nothing in Biology makes sense, except in the light of Evolution” by Theodosius Dobzhansky is
the quote that sums up the importance of Evolution to Biology. The genetic basis of Evolution
has been described and the applications of these principles to examples are covered, i.e.
applications of probability and statistics to populations. Evolution as it relates to population size
and density. The Wright-fisher model with the Hardy-Weinberg equations as a special case:
rigorous development of the limit concept; continuity; discrete dynamical systems; effect of
sample size in the Chi-square test; an introduction to graphs and their use in genetics.
Governor’s School Student Projects

Students had the opportunity to be engaged in a variety of research projects. The projects centered around the following topics: Fly Longevity, Fly Behavior, Discrete Probability Distributions, Bayesian Statistics, Probability, Proteomics, Microarray Data Analysis, and Cancer Cells/Cell Culture. In each project, model building and data analysis played a critical role and was interwoven in a statistical and biological context. Listed below is a brief description of each project as well as the names of students involved in the research. The students reported their research findings to their parents and university faculty on the last day of the Governor’s School.

Dr. Joplin: (Forensic Etomology)
1. Myranda Gorman
2. Michelle Hoang

Insects perform a valuable service of breaking down carcasses in the environment and are known to utilize dead organisms in a succession that can be used to date time of death where other methods are inconclusive or where evidence is lacking. We have utilized new pieces of liver to collect species that appear on dead meat to ask how many species are involved, how the species composition change with time and what is the natural history of this succession.

Dr. Hugh Miller: (Cancer Cells/Cell Culture)
1. Stephanie Alu
2. Sophia Cui
3. Nathan Liu
4. Ruchi Shah
5. Michael Lee
6. Nicholas Lobo
7. Laura Sheets

A lymphoma cell line called U937 appears to have heterogeneous sizes. The students tried to answer the question; does the size of U937 cells change as the cells age in culture? Cells that had been cultured for various times were applied to microscope slides and images of random fields were captured. Cell areas were analyzed using the Image J software.

Dr. Nicole Lewis: (Probability)
1. Spencer Edmonds
2. Carrie Romesburg
3. Brooklyn Runyan
4. Diana Hobbs

Probability – Sampling With Replacement versus Sampling Without Replacement

A box contains \( n \) tickets numbered 1, 2, ..., \( n \). A random sample of \( n \) tickets is selected from the box, one at a time. A “match” occurs if the ticket numbered \( i \) is selected on the \( i \)th draw.

a. Find the probability of at least one match if sampling is done
   o With replacement
   o Without replacement

b. What happens as \( n \) reaches infinity?
Dr. Nicole Lewis: [Discrete Probability Distributions]
1. Elizabeth Thompson   2. Gracelyn Bowers

a. Discuss and provide examples for these discrete probability distributions.
b. Under what conditions do they give similar probabilities?

Dr. Nicole Lewis: [Bayesian Statistics]. Spin a penny on a table. Let \( p \) denote the probability that it lands heads. We want to estimate this probability starting with different prior beliefs about \( p \).
1. Nicole Chandler   3. Kendra Smith
2. Sanchit Wadhawan   4. Muhammad Feroze

a. We will use a histogram to model the prior belief.
b. We will use a uniform prior.
c. Simulate the posterior distributions from the priors and compare the results. Suppose one is interested in predicting the number of heads \( y \) in a future sample of size 25. Compute the predictive probabilities of \( y \) using the different priors. Compare the results.

Dr. Karl Joplin: [Micro-Array Data Analysis]

Students were introduced to microarray data from a study of diapausing and non-diapausing flesh flies, *Sarcophaga crassipalpis*. The data were normalized and examined for genes that are diapause up- or down-regulated during this developmental state. Genes were then identified using the GenBank dataset.

Dr. Nicole Lewis: [Peptide Identification]
2. Nathan Carothers   4. Evan Majic

Proteomics is a vast analysis of proteins, particularly their structure, function, abundances, and variations and modifications. In proteomics, scientists begin with the protein and work backwards to determine the gene that is responsible for its production. The basic idea of any protein identification method is to match an observed spectrum to a theoretical spectrum of the proposed peptide. It is extremely difficult to identify intact proteins and so the proteins are broken into short peptides and examined separately.

(a) For any given peptide, create the theoretical spectrum using the m/z value of each ion types.
(b) Plot the theoretical spectrum against the observed spectrum and make comparisons.
(c) Determine which ions help reduce the noise peaks in the observed spectrum.
(d) Compare the values of the goodness of fit measures when using different prior beliefs about the probability of observing a peak (presence of an ion).
APPENDIX E

2014 Student Evaluation Results
The Tennessee Governor’s School for Scientific Models and Data Analysis

I. Overall Program (22 out of 30 students completed the evaluation form)

Your overall rating of the 2014 Governor’s School for Scientific Models and Data Analysis Program is that it was:

- Excellent--------------------- 02/22 09%
- Very good--------------------- 11/22 50%
- Good------------------------ 09/22 41%
- Fair------------------------ 00/22 00%
- Unsatisfactory/poor----------- 00/22 00%

II. Academic Component/Workload

The opportunity to earn seven hours of university academic credit was:

What is the level of your satisfaction with the Governor’s School Program offered as a university credit program?

- The for-credit aspect is very important to me--------------------- 14/22 64%
- I am neutral on the for-credit aspect--------------------- 07/22 32%
- I would have preferred that the program be offered on a non-credit basis--------------------- 01/22 04%
- Not sure--------------------- 00/22 00%
- No answer--------------------- 00/22 00%

III. Core Educational Program

Did you find the material covered interesting?

- All of the time--------------------- 01/22 04%
- Most of the time--------------------- 17/22 78%
- Some of the time--------------------- 01/22 04%
- Occasionally--------------------- 03/22 14%
- Not at all--------------------- 00/22 00%

Do you think the academic material provided was useful to your learning the course material?

- All of the time--------------------- 00/22 00%
- Most of the time--------------------- 10/22 45%
- Some of the time--------------------- 09/22 41%
- Occasionally--------------------- 03/22 14%
- Not at all--------------------- 00/22 00%
The division of time spent on classroom lectures, team projects and homework was well-balanced:

- All of the time: 03/22, 14%
- Most of the time: 07/22, 32%
- Some of the time: 05/22, 22%
- Occasionally: 02/22, 10%
- Not at all: 05/22, 22%

In general, did you have enough time (in and out-of class) to finish all of your homework and project assignments:

- Yes: 20/22, 90%
- No: 02/22, 10%

Weekly tests appropriately covered material presented in class and in-class learning exercises:

- All of the time: 02/22, 10%
- Most of the time: 07/22, 32%
- Some of the time: 06/22, 26%
- Occasionally: 04/22, 18%
- Not at all: 03/22, 14%

You feel that the scores you earned on tests reflected the actual extent to which you mastered course material:

- Very closely: 4/22, 18%
- Somewhat: 11/22, 50%
- Not very much: 05/22, 22%
- Not at all: 02/22, 10%

The assigned team design projects were interesting and contributed to your learning experience:

- All of the time: 05/22, 23%
- Most of the time: 06/22, 27%
- Some of the time: 09/22, 40%
- Occasionally: 00/22, 00%
- Not at all: 02/22, 10%

IV. On-Campus Meals

Did you feel that the food served on-campus was of good variety and quality:

- Excellent: 00/22, 00%
- Very Good: 01/22, 05%
- Good: 03/22, 13%
- Fair: 05/22, 23%
- Poor/Unacceptable: 13/22, 59%
V. Dormitory Lodging

You feel that your stay in the Luntsford Apartments dormitory was:

- Excellent: 04/22, 18%
- Very Good: 09/22, 40%
- Good: 07/22, 32%
- Fair: 02/22, 10%
- Poor/Unacceptable: 00/22, 0%

VI. Faculty (Professor)/Courses

The teaching effectiveness and general helpfulness of Professor Dr. Karl Joplin was:

- Excellent: 00/22, 00%
- Very good: 01/22, 05%
- Good: 06/22, 26%
- Fair: 11/22, 51%
- Poor/Unacceptable: 04/22, 18%

The teaching effectiveness and general helpfulness of Professor Dr. Nicole Lewis was:

- Excellent: 06/22, 26%
- Very good: 12/22, 55%
- Good: 03/22, 14%
- Fair: 01/22, 05%
- Poor/Unacceptable: 00/22, 0%

VII. Resident Counselors

The effectiveness and helpfulness of the four Governor's School Counselors (as a group) in providing dormitory oversight and in accompanying you on group activities were:

- Excellent: 02/22, 10%
- Very Good: 10/22, 46%
- Good: 07/22, 31%
- Fair: 03/22, 13%
- Poor/Unacceptable: 00/22, 0%
VIII. Special Activities

The following activities included in the 2014 Governor’s School for Scientific Models and Data Analysis Program were of substantial value and should be repeated in future programs: Based on “Excellent”, “Very Good”, and “Good”.

ETSU Campus Arboretum/Planetarium (Dr. Foster Levy)----------------------- 00/22 00%
SNAP-ON Tools (Jon Carley)---------------------------------------------------------- 22/22 100%
ETSU Planetarium/Observatory (Dr. Gary Henson)-------------------------------- 22/22 100%
ETSU Medical School Laboratory (Dr. Mitch Robinson)----------------------- 22/22 100%
Gray Fossil Site, Paleontology Dig (Dr. Blaine Schubert)----------------------- 22/22 100%
Eastman Chemical Company, Kingsport, TN (Ms. Angela Haga)------------------ 22/22 100%
Aerojet Rocketdyne (Mary Jane Greene/Ms. Angela Haga)------ 22/22 100%
Historic Jonesborough, Jonesborough, TN (Dr. Jack Rhoton)------------------ 22/22 100%
Roan Mountain State Park, Roan Mountain, TN (Jennifer Bauer)---------- 22/22 100%
Bays Mountain State Park, Kingsport, TN (Dr. Jack Rhoton)------------------ 22/22 100%
The Carter Family Fold, Hiltons, VA (Dr. Jack Rhoton)----------------------- 22/22 100%
Off-campus meal events---------------------------------------------------------- 22/22 100%
# APPENDIX F

## 2014 Comments (Field Trips)
The Tennessee Governor's School for Scientific Models and Data Analysis

**COMMENTS:** Opinions of scholars

<table>
<thead>
<tr>
<th>Location</th>
<th>Facility</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ETSU Campus Arboretum, Johnson City, TN:</strong></td>
<td>(Dr. Foster Levy)</td>
<td></td>
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<tr>
<td></td>
<td>Comments: <em>none</em></td>
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<tr>
<td><strong>Snap-On Tools, Elizabethton, TN:</strong></td>
<td>(Mr. Jon Carley)</td>
<td></td>
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<tr>
<td></td>
<td>Comments: <em>none</em></td>
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<tr>
<td><strong>ETSU Planetarium/Observatory, Johnson City, TN:</strong></td>
<td>(Dr. Gary Henson)</td>
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<td></td>
<td>Comments: <em>none</em></td>
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<tr>
<td><strong>ETSU Medical School Laboratory, Johnson City, TN:</strong></td>
<td>(Dr. Mitch Robinson/Dr. Jack Rhoton)</td>
<td></td>
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<td>Comments: <em>none</em></td>
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<tr>
<td><strong>Gray Fossil Site, Paleontology Dig, Gray, TN:</strong></td>
<td>(Dr. Blaine Schubert)</td>
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<tr>
<td><strong>Eastman Chemical Company, Kingsport, TN:</strong></td>
<td>(Mrs. Sherry Morelock/ Angela Haga)</td>
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<td><strong>Roan Mountain State Park, Roan Mountain, TN:</strong></td>
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<td><strong>Aerojet Rocketdyne, Jonesborough, TN:</strong></td>
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<tr>
<td><strong>Bays Mountain State Park, Kingsport, TN:</strong></td>
<td>(Mr. Fred Hilton/Dr. Jack Rhoton)</td>
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<td>Comments: <em>none</em></td>
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<td><strong>The Carter Family Fold, Hiltons, VA:</strong></td>
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<td></td>
<td>Comments: <em>none</em></td>
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On-campus meal events

Comments:
- Food was terrible.
- Food was always greasy or cold.
- Too many potatoes!
- Need more pizza!
- Food was good for what it was.
- Food was just bad!
- Get new food provider!

Luntsford Apartments (Dorm)

Comments:
- Elevator is very slow.
- Apartments were very nice.
- Big, nice rooms, but needs more hot water.
- Very nice, but we needed more toilet paper.
- Spacious and clean.
- Bigger beds.
- More desk space.
- More trash cans on each floor.
- The social room was a bit small, but otherwise it was good.

Overall Program Evaluation

Comments:
- I had a great time, made amazing friends, and learned a ton.
- Had a lot of fun and learned a lot.
- The classes were challenging, but not for me.
- The counselors were strict, but just trying to ensure our safety.
- More activities.
- Loved the field trips.
- An eye opening experience for me as a rising junior.
- Had fun and learned a lot about how college is going to be.
- A very challenging experience.
- The food program needs to be changed
- The counselors were great. They made governor’s school fun.
- It was a fun experience that allowed me to get out of my private school bubble.
- It was fun and the time was well managed, but lectures were too long.
- I enjoyed my experience. I missed home, but the credits were well worth it.
- The program should have been longer. Five weeks is not long enough to learn the material.
- I enjoyed learning new material, meeting new people, and going on all the field trips.
- I liked the semi-college feel, the classes were difficult, but fun and I loved making new friends.
- Staff was good.
- An overall learning experience.
- I really enjoyed meeting new people, learning new information in biology and statistics was a great experience and will help me decide a path to take in the future when making a decision about my major in college. I also am glad to have the opportunity to live at college before actually attending college next year.
- Dr. Lewis had interactive lessons to keep students engaged. Dr. Joplin explained biology in a way that was easy to understand most of the time. Classes were very informative and the project I did was interesting and insightful. I really enjoyed the field trips. The activities planned by the counselors were fun.
- I love Governor’s School because you can make friends and not just leave them at Governor’s School. You can keep them for life!
- Governor’s School was an amazing experience that I will never forget. I made a lot of great friends.
- I enjoyed it plenty. It expanded my horizons in a variety of fields.
- The counselors are really fun! I loved toing to the activity center too.
- Governor’s School is an experience I will carry with me for a lifetime.
- The counselors planned for events. The staff was very helpful. The classes were interesting and the projects were interactive.
- It was a blast! I enjoyed being able to experience college with my peers at such an age, and be able to meet new people with similar goals in life.
- I made friends for a lifetime. However, more library time would be appreciated. It was a great experience and I will never forget it.
- The field trips were great!
- It was good overall, but the classes were hard. The professors went too fast. I had a good time and met great people. I liked the field trips.
- The projects were interesting, but I wish we had gone on more medical field trips like Quillen.
- Governor’s School was a fun opportunity to get away from home for a month and live at a college. Dr. Joplin’s lectures were far too long.
- I have enjoyed my experience here at Governor’s School and ETSU. Even though it took away half of my summer it was well worth it. Being here helped me make decisions about the rest of my high school and my future in college.
- I loved being here for Governor’s School and ETSU. Best way to spend half my summer. Loved Zumba.