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State Residential STEM Schools

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State Residential STEM Schools A Case Study

Julia L. Roberts, Ed.D.

Schools with a focus on mathematics and science come in many forms, one of which is a residential school. Residential schools provide one of the educational services on the continuum planned to meet the unique needs of gifted adolescents (Cross & Miller, 2007; Rollins & Cross, 2014). Fifteen states have a state residential school that highlights science, technology, engineering, and mathematics (STEM). These schools provide opportunities for students to study at advanced levels and to do so with academic peers. Such schools allow students to accelerate their learning, especially in STEM subjects. Students at specialized state schools come from all corners of a state.

Three major reasons prompt establishing state residential STEM schools: One is educational, one relates to economic development, and the other is to keep exceptionally capable students in the state. The first goal is to offer opportunities for exceptional students to study at advanced levels. Many schools do not have the resources to develop the outstanding talents of students with interest in STEM careers. The second goal is to build a leadership cadre with expertise in STEM to promote economic development. The National Science Board (2010) put forth that “the long-term prosperity of our Nation will increasingly rely on talented and motivated individuals who will comprise the vanguard of scientific

and technological innovation” (p. v). The third goal is to stem the “brain drain.” State and local leaders are concerned about the number of students leaving the state with the fear that they will not return. These three reasons have prompted several states to establish state residential high schools with a focus on STEM.

Information About State Residential STEM Schools

Clarion Call For STEM Education

National reports have encouraged states to establish state residential schools.

Rising Above the Gathering Storm (National Academy of Sciences, 2007) recommended the expansion of two approaches to improving K–12 science and mathematics education that are already being implemented. One of the recommended approaches was establishing statewide specialty high schools: “Statewide specialty high schools can foster leaders in science, technology, and mathematics” (p. 9). Creating STEM-focused schools is one of the seven recommendations of the President’s Council of Advisors on Science and Technology’s (2010) *Prepare and Inspire: K–12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future*. The report highlighted that “STEM-focused schools represent a unique National resource, both through their direct impact on students and as laboratories for experimenting with innovative approaches” (p. xii).

Brief History of State Residential STEM Schools

The first state residential STEM school was the North Carolina School of Science and Mathematics. It started in 1980 as an initiative of Governor James Hunt. The Illinois Mathematics and Science Academy opened in 1986, with the Texas Academy of Mathematics and Science getting its start in 1988. Since the 1980s, 12 other states have opened state residential STEM schools for a total of 15 states. Kentucky is the only state to have two such schools, with the second one planning to open in 2015. Table 1.1 details the schools.

TABLE 1.1
State Residential STEM Schools

School	Opening Year	Location	Website
Alabama School of Mathematics and Science	1991	Mobile, AL	http://www.asms.net
Arkansas School for Mathematics, Sciences, and the Arts	1993	Hot Springs, AR	http://www.asmsa.org
Craft Academy for Excellence in Science and Mathematics	2015	Morehead State University, Morehead, KY	http://www.moreheadstate.edu/craft-academy/
Garron Academy of Mathematics and Science in Kentucky	2007	Western Kentucky University, Bowling Green, KY	http://www.wku.edu/academy
Georgia Academy of Aviation, Mathematics, Engineering, and Science	1997	Middle Georgia State College, Cochran, GA	http://www.mga.edu/games/
Illinois Mathematics and Science Academy	1986	Aurora, IL	http://www.imsa.edu
Indiana Academy for Science, Mathematics, and Humanities	1990	Ball State University, Muncie, IN	http://www.bsui.edu/academy
Kansas Academy of Mathematics and Science	2009	Fort Hays State University, Hays, KS	http://www.fhsu.edu/kams
Louisiana School for Math, Science, and the Arts	1983	Northwestern State University, Natchitoches, LA	http://www.lmsa.edu
Maine School of Science and Mathematics	1995	Limestone, ME	http://www.mssm.org
Mississippi School for Mathematics and Science	1987	Mississippi University for Women, Columbus, MS	http://www.tchemsms.org
Missouri Academy of Science, Mathematics, and Computing	2000	Northwest Missouri State University, Maryville, MO	http://www.nwmissouri.edu/masmc/
North Carolina School of Science and Mathematics	1980	Durham, NC	http://www.ncssm.edu
Oklahoma School of Science and Mathematics	1990	Oklahoma City, OK	http://www.ossm.edu
South Carolina Governor's School for Science and Mathematics	1988	Hartsville, SC	http://www.sgssm.org
Texas Academy of Mathematics and Science	1988	University of North Texas, Denton, TX	http://tams.unt.edu

Creating STEM-focused schools is one of the seven recommendations of the President's Council of Advisors on Science and Technology's (2010) *Prepare and Inspire: K–12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future*. The report highlighted that "STEM-focused schools represent a unique National resource, both through their direct impact on students and as laboratories for experimenting with innovative approaches" (p. xii).

What these schools have in common are the following: They are residential and open to students throughout the state, they receive support from the state budget, and students are selected based on their ability and interest in careers in science and mathematics. All of the schools include juniors and seniors, with a few also having sophomores in their student populations. A few of them also include the arts or humanities in their focus. Examples are the Arkansas School of Mathematics, Sciences and the Arts and the Indiana Schools of Science, Mathematics and Humanities.

Types of State STEM Schools

Two types of state residential STEM schools are represented in the 16 schools. The original model was the school with its own campus. The second model is the school located on a university campus. The free-standing schools have their own faculties and campuses. These schools have their own buildings and provide all services required by residential students. For example, they have their own laboratories, dining halls, and recreational facilities. Most of the state residential STEM schools represent this model.

The second model is characterized with a residence hall for the students on a university campus. Students take university courses with traditional college students and enjoy the services that are available on the campus. This model provides opportunities that are available on a university campus, such as visiting lecturers, musical events, recreational facilities, and expertise for research mentorships for students. This model also has the advantage of a lower budget.

Research on State Residential STEM Schools

Almarode, Subotnik, Crowe, Tai, Lee, and Nowlin (2014) stated, "Specialized science high schools offer an environment, both academic and social, in which interested students can explore the scientific world with both support and challenge" (p. 309). Rollins and Cross (2014) found "no evidence to support the notion that the residential school experience was harmful to student psychological development" (p. 337).

Wai, Lubinski, Benbow, and Steiger's (2010) longitudinal study showed that participating in numerous advanced precollegiate learning opportunities was linked to later accomplishments in STEM. The study by Almarode et al. (2014) found "49.8% of the selective STEM school graduates completed an undergraduate STEM degree" (p. 321) compared with 22.6% of all U.S. students entering college who complete a STEM undergraduate degree (National Science Board, 2012). Almarode et al. (2014) found that "a student's feelings of intellectual capacity in high school and the stability of interest in STEM related areas are strongly and positively associated with their persistence and earning an undergraduate degree in STEM" (p. 327).

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A Case Study: The Gatton Academy of Mathematics and Science in Kentucky

The Carol Martin Gatton Academy of Mathematics and Science in Kentucky is an example of a state residential school that is located on the campus of Western Kentucky University (WKU). Gatton Academy students live in a specially designed residence hall and learn in university classes. There are many similarities with other state residential STEM schools, yet there are differences as well.

Getting Started

Dr. Julia Link Roberts, Director of The Center for Gifted Studies at WKU, and Dr. Charles McGruder, professor of physics and astronomy at WKU, submitted a proposal to the Kentucky Council of Higher Education in 1998. This proposal was to study the concept of having a state residential STEM school in Kentucky. Almost 10 years passed between the submission of this proposal and the opening of the doors to the first students at The Gatton Academy.

Years of advocacy and planning took place between the 1998 proposal and the state's eventual adoption of the idea. Roberts (2010) provided details of the advocacy and planning that led to a state residential STEM school being

included in the state budget. Important decision makers to be informed about this opportunity included the candidates for governor, legislators, superintendents of school districts, and others in positions of influence.

In 2005, the state budget included funds to renovate a residence hall on the campus of WKU. In August 2007, The Gatton Academy opened, and Florence Schneider Hall became the home of The Gatton Academy and The Center for Gifted Studies. In 2014, funding was approved at the state level that will allow reaching the initial vision of 200 total students. An expansion of Schneider Hall will add student rooms and a community space large enough for all students and staff to gather for seminars and other total group meetings.

Sending Schools

The Gatton Academy provides a way for educators across the Commonwealth of Kentucky to extend advanced learning opportunities for high school students. Students who come to The Gatton Academy remain dually enrolled with their sending high schools. The state's per pupil funding continues to go to the sending school. All students at The Gatton Academy take the state assessment, and their scores are included with scores at the home high schools. In addition, educators at the sending schools are encouraged to celebrate honors and awards that the students receive, honoring the years spent learning during the previous years. These benefits were put in place to recognize and honor the local school districts and to assuage educators' concerns about their student(s) going to The Gatton Academy.

Dual enrollment is also a benefit to Gatton Academy students. It keeps the students connected to their home area. It allows the student to participate in commencement and other special occasions with students with whom they grew up.

The Application Process

Students around the state apply for admission to The Gatton Academy in a process similar to applying to a selective college. The online application is available from the beginning of the school year and is due on February 1. Students apply as sophomores, and they must be Kentucky residents. Included in the application submission are the student's transcripts from the freshman and sophomore years, ACT or SAT scores, letters of recommendation, and essays. Approximately 100 applicants are invited to come for a day of interviews as the

final step in the process. An important part of the application process is the applicant's interest in pursuing a career in one or more STEM disciplines. Applicants share their interests in STEM as well as potential career goals through essays and interviews. Approximately 60 rising juniors receive invitations to join the upcoming class at The Gatton Academy. With the planned expansion, the number in each class will increase to 100 annually.

Student Benefits

The Gatton Academy “allows [students] to engage in learning at levels at which most of their age-mates are not yet ready to learn” (Roberts, 2013, p. 199). Students at The Gatton Academy graduate from high school with a minimum of 60 undergraduate hours. The state budget provides tuition, room, and board for students. Tuition allows students to take up to 19 credits of college coursework each semester during their junior and senior years of high school. Housing is provided with other Gatton Academy students, and a meal card allows students to eat at various locations on campus. Students are issued a laptop that includes software needed for classwork. Other benefits include the living-learning community, curriculum that offers advanced learning while still in high school, research opportunities, global experiences, and extracurricular opportunities.

A community of learners. Gatton Academy students live together in Florence Schneider Hall, a 1928 building that was renovated specifically to be the home of The Gatton Academy. The building is located in the heart of the campus of WKU. The students live “Shaker style” with the girls on one side of the building and boys on the other. There are the same number of rooms for males and females, so the gender balance is always in place.

Community spaces allow students to gather for studying and socializing. There are community spaces on three of the four floors in between the wings. In addition, space on each wing has a table, chairs, and sofas to provide another option for studying and gathering together. The fourth floor has a space large enough for all of The Gatton Academy students to hold seminars or for other occasions for all students. The expansion of the building will include a space for 200 students to get together for seminars, guest speakers, or other purposes.

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Students value opportunities to learn with others who are equally interested in learning. Most have never needed to ask for help; however, in this learning-living environment, they have ready access to others when they have questions or need assistance. They appreciate opportunities to learn with ideamates, others who are passionate about one or more areas of science, technology, engineering, and/or mathematics.

Special arrangements for safety are made for these students who are younger than most university students. A curfew is in place, and 24-hour surveillance is provided. A person is at the desk the whole time students are in residence. A residential counselor, who is a college graduate, lives on each wing of the building with Gatton students. Also, students scan their cards when they enter and exit the building.

Gatton Academy students do not have cars. The exception to the no-driving regulation is the few students who have permission to use a vehicle for transportation home on closed weekends. Those cars are parked at a remote parking lot and only accessed for driving to and from their homes. Approximately once a month, the building closes and students go home for the weekend with their families. Some of those closed weekends coincide with scheduled breaks for holidays.

Curriculum. The curriculum at the state residential STEM schools addresses the requirements for high school students and extends opportunities to learn at advanced levels. High school credits that are not yet met will be addressed with college courses in those curricular areas. All classes at The Gatton Academy are university classes taught by professors. Almost all classes are taken with regular college students. The exception would be a mathematics class in which there are so many Gatton Academy students that they fill a class, or the Computational Problem Solving class that was designed for and is a requirement for students at The Gatton Academy.

Gatton students begin mathematics study at the level at which they are prepared to start. Opportunities at sending high schools determine the starting class for most students. The math requirement for applying is the completion of Algebra II and Geometry. Some incoming students have completed more advanced math courses, so they may start with Calculus I or II. Appropriate placement of students in the math sequence is key to success in the study of mathematics.

All students take one course each in biology, chemistry, computer science, and physics during their 2 years at The Gatton Academy. In addition, they are required to select one of those content areas and take a second course in that sequence. They also must take three to four STEM electives from agriculture,

architecture, astronomy, biology, chemistry, computer science, engineering, geography, geology, health sciences, manufacturing, mathematics, meteorology, physics, and/or psychological science.

A program option for Gatton Academy students is the STEM+Critical Language program, where students have the opportunity to study and master a critical language. The two critical languages from which students choose are Mandarin Chinese and Arabic. The Class of 2015 had eight students taking intensive language courses in Mandarin Chinese or Arabic. Students achieve a higher level of mastery of the language each semester. Students studying Chinese have the opportunity to matriculate into the Chinese Flagship Program at WKU after their first year of studying the language. Students have opportunities for language immersion in summer travel experiences. The STEM+Critical Language track is considered an equivalent to engaging in independent, mentored research.

Research opportunities. One of the exceptional opportunities for Gatton Academy students is the opportunity to engage in research from the time they enter the residential program. Although research is not a requirement for Gatton Academy students, 95% of the Class of 2014 participated in research. Gatton students engage in research with university faculty as mentors. Information about undergraduate research opportunities is shared with students at the beginning of their Gatton Academy experience. During Adventure Week (orientation for new students), WKU professors come to Florence Schneider Hall to highlight and share their research interests. Students may follow up by approaching the professors to serve as their mentors. Areas of potential research include agriculture, architecture, astronomy, biotechnology, biodiversity, bio-informatics, chemistry, computer science, civil engineering, electrical engineering, mechanical engineering, geography, geology, manufacturing, mathematics, physics, and psychology. Research is presented at university, state, and national conferences. A few Gatton students have published their research in professional journals.

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Summer research opportunities are supported by a gift from Mr. Carol Martin Gatton. This support is available for conducting research with a Western Kentucky University professor as mentor or elsewhere at a research facility. These internships are provided during the summer between the students' junior and senior years at the Academy. Examples of summer research included using

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Google Glass to develop an app for WKU, lung cancer metabolism, and using the micro-EDM to study aerospace materials.

Quality research experiences are important for premier scholarship competitions. Submitting research results was the first step in the 2014 Siemens Competition of Math, Science & Technology. Gatton Academy students were semifinalists in the Siemens Competition with research topics that included studying micro-sized nuclear power sources, plasma physics for magnetic fusion

energy, and calculation of stationary scattering states in 1D problems. Other research competitions also are open to high school students and undergraduate students, and Gatton Academy students usually qualify for both categories of competitions.

Global experiences. Students have three primary travel experiences in which they may participate. During the winter term, some Gatton Academy students participate in research in the rain forest in Costa Rica or travel to Italy or Greece (alternate years). Another study abroad experience occurs in England in the summer. Students spend 3 weeks at Harlaxton College in Grantham, England, where they study English literature and travel to sites of literary significance.

Gatton Academy students have spent their summers doing research in countries around the world. Others have immersed themselves in the study of a language in another country. Becoming a global citizen is an expectation of Gatton Academy graduates. As students are preparing for leadership roles in STEM disciplines, it is important to have a global perspective.

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Extracurricular opportunities. Students engage in a variety of extracurricular activities, both at the high school and college level. They have activities within The Gatton Academy, and they also participate in extracurricular activities at WKU. They host a mid-winter dance as well as a prom. Social activities are available on weekends throughout the year. Students may audition for the orchestra, band, and choral groups at WKU. Opportunities for developing leadership

and participating in interest groups or clubs are readily available.

Staff at The Gatton Academy

Staffing for The Gatton Academy is planned to offer needed support for students and to manage the ongoing operations of the state residential STEM school. The staff specializes in counseling, academic support, as well as student life. Each has specific responsibilities, and all work together to encourage and support the students.

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Statewide Reach

The Gatton Academy is a statewide school. Consequently, it is important that students represent the entire state. In the 8-year history of The Gatton Academy, 113 of Kentucky's 120 counties have had one or more students as a student.

Getting the word out about the opportunity to apply for The Gatton Academy is an ongoing process. Sessions are held throughout the state at professional meetings and at sessions offered within regional communities. Mailings also provide information about the opportunities available at the state residential STEM high school.

Programming for Younger Students

“While the majority of the residential STEM schools have developed outreach programs throughout their histories, The Gatton Academy of Mathematics and Science in Kentucky represents a novel inversion of the trend” (Roberts & Alderdice, 2015). The Center for Gifted Studies at Western Kentucky University had more than a two-decade history of offering summer and Saturday programs to students in grades 1–10 when The Gatton Academy opened in 2007. The Center for Gifted Studies offers residential and nonresidential programming, including VAMPY, a 3-week program for seventh through tenth graders, and SCATS, a 2-week camp for sixth through eighth graders. The Gatton Academy and The Center for Gifted Studies share space at Florence Schneider Hall. The

missions of both are complementary, and staff members provide support for each other.

Recognition

Newsweek and *The Daily Beast* recognized The Gatton Academy as the number one public high school in the United States in 2012 and 2013. *The Daily Beast* continued that top recognition in 2014. In the 2012 Intel Schools of Distinction Recognition, The Gatton Academy was named one of the three outstanding high school programs in the country. Such recognition was never a goal, yet the recognition of the programming provided by The Gatton Academy has helped spread the word about this educational opportunity.

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Expansion of The Gatton Academy

The original goal for The Gatton Academy was to have the capacity for 200 students—100 juniors and 100 seniors. When the original funding and bonding were available, the amount allowed for keeping the footprint of Florence Schneider Hall and renovating to accommodate 120 students. The number of Gatton Academy students will go up by 40 in the fall of 2016 and then to the full capacity of 200 students for the 2017–2018 academic year. The expansion was made possible by a generous gift and increased funding in the state budget in order to support the increased number.

Concluding Remarks

Fifteen states have implemented residential schools with a focus on STEM. These schools span a 35-year history. Such schools address the needs of students who are ready to learn at advanced levels that are not available at their sending high schools and who benefit from having proximity to academic peers or idea-mates.

Students who thrive at a state residential high school are eager to learn at advanced levels, enjoy the living-learning community, and are ready to take charge of both aspects of their lives. With the supports that are in place at The Gatton Academy, these young people achieve at high levels and engage in extracurricular activities, research, and global experiences. States benefit as these young people are interested in pursuing careers in science, technology, engineering, or mathematics.

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Discussion Questions

1. What are elements of programming at The Gatton Academy that are appealing to students of advanced abilities and high interest in STEM content areas?
2. Which of these elements can be implemented in a nonresidential setting, and why would you want to do that?
3. How could the advocacy efforts that resulted in The Gatton Academy be generalized to something you want to implement in your school or school district?
4. How can STEM programming at The Gatton Academy or at a state residential school near you impact STEM programming in your school or school district?

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