Experiences from the Tulsa Mathematics Equity Academy

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Introduction

The Tulsa Mathematics Equity Academy (TMEA) has been held at The University of Tulsa for the past 7 summers. The TMEA started as an outgrowth of our popular Sonia Kovalevsky High School Mathematics Days. Over the past seven summers the directors of the program have tried several formats and different content. This paper will summarize our experience with a view toward offering tips on how to start a residential summer academy. The TMEA is a residential academy for rising 8th and 9th grade girls. No academic credit is given. Our academy is funded by the Oklahoma State Regents for Higher Education through a competitive proposal process. For residential academies, a maximum of $525 per student per week can be obtained.

Developing a Schedule for a Residential Academy

One of the most daunting tasks originally confronting us was that of keeping rising high school students occupied productively for an extended period of time. The first step in planning a summer academy is to design a single day. Identifying blocks of time for instruction, recreation, meals, and rest for one day provides the basis for an overall plan. Setting up a structure for one academy day, will quickly make clear how much instructional time is available. What originally appears to be a huge expanse of time quickly shrinks to manageable size. Once a basic daily routine is established, we can determine how many days the academy requires—usually one or two weeks. The basic structure on any given day can be altered to accommodate special speakers or field trips. Figures 1 and 2 show the schedule for the 2002 TMEA. Having a finely tuned schedule with all logistic details attended to prior to the academy frees the faculty to concentrate on teaching and interaction with the students.

We have experimented with different formats over the years:

- Two-week academy with time off during the intervening weekend.
- One-week academy from Sunday evening to Friday afternoon.

Even at the relatively young age of rising 8th graders, a one-week academy didn't give us enough time. We have settled on a two-week academy format, running Sunday evening through Friday afternoon. Our students, all from Oklahoma, return home on the intervening weekend. Only once have we had a student fail to return from the weekend break.

When students accept positions in our academy, they must commit to being in residence throughout. Building a community of scholars living and working together is such an important aspect of this experience that we can't permit students to attend athletic practices or other outside functions. Parents and students understand this when accepting positions in the academy. It is

also important during the academy to make sure that the students get enough sleep. Teenagers need a lot of rest and can be very cranky when they don't get the proper amount. Staying focused on mathematics is particularly difficult if one has been up too late with new friends. Therefore, a good schedule will include enough free time and activities so that the students can chat and get to know each other without staying up too late at night. Building and programming Lego robots is a good activity for this. On the other hand, students also need a respite from interactions with others, so we conclude each workday with a yoga session before dinner. This gives the students time to be quiet and recharge for the evening.

At the TMEA we have tried taking the students on field trips to local businesses; however, bringing in guest speakers works better for us. Interesting guest speakers provide more benefit in terms of time drawn from instruction, applicability to the subject matter, and expense for transportation. For the TMEA 2002, we were able to have as speakers Charles Chibitty, the last surviving Comanche code talker; Catherine Kingsley, a native Oklahoman who worked as a cryptographer at the FBI during World War II; and Leroy Fischer, a retired history professor who was stationed at Bletchley Park, England, during World War II.

We begin and end our academy with a session for participants and parents. The initial meeting, the first evening of the academy, gives an overview of our activities and explains to students and parents our expectations for both of them. Parents are told when and where to pick up their daughters and how to communicate with them during the academy. We ask parents to refrain from calling and visiting during the academy. We give the parents handouts with all this information and also the web site address where they will be able to view a daily journal with photos of the academy. Students are given notebooks with our daily schedule, rosters of participants, some course handouts, and the rules of the academy. We review this information with both the parents and the girls.

The final presentation by students to parents and mathematics department faculty at the conclusion of the academy is an important part of the academy. Preparation of these presentations provides small groups of students with opportunities to reflect together about their experiences. Generally, the students learn a great deal by having to clearly explain part of what they learned. It is empowering to the students to feel that they are presenting something with which their parents are unfamiliar. The students enjoy the role of teacher, and we are amazed every year by their creativity. The final presentation session ends with a reception during which the girls, faculty and staff, and parents can visit.

Figure 1. Tulsa Mathematics Equity Academy –Week 1; July 7-19, 2002

	Sun, July 7	Monday, July 8	Tuesday, July 9	Wed, July 10	Thurs, July 11	Friday, July 12
7:00 a.m.		Rise-N-Shine	Rise-N-Shine	Rise-N-Shine	Rise-N-Shine	Rise-N-Shine
8:00 a.m.		Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers
9:00 a.m. 10:00 a.m. 11:00 a.m.		Intro to Ciphers Cairns (9:00-11:00 a.m.) KEP M216	Ciphers Cairns (9:00-11:00 a.m.) KEP M216	LOGO Programming Farrior (9:00-11:00 a.m.) KEP L1/L2	Ciphers, Number Theory Cairns (9:00-11:00 a.m.) KEP M216	LOGO Programming Farrior (9:00-11:00 a.m.) KEP L1/L2
noon		Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)
1:00 p.m.		Rest Time Lottie Jane 12:30-1:30 p.m.	Rest Time Lottie Jane 12:30-1:30 p.m.	Rest Time Lottie Jane 12:30-1:30 p.m.	Buckley—Enigma, WWII in North Atlantic, U110 (12:30-2:30 p.m) BAH 315	Clean room and pack to go home
2:00 p.m. 3:00 p.m.		Intro to LOGO Programming Farrior (1:30-3:45 p.m.) KEP L!/L2	Buckley—WWII Intro "Man Who Never Was" (1:30-3:45 p.m.) BAH 315	Lego Robots Bellovich/Harrington (1:30-3:45 p.m) KEP M216	Katherine Kingsley (2:30-3:30 p.m) BAH 315	Buckley—WWII in the South Pacific (1:30-3:45 p.m) BAH 315
4:00 p.m.		Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Leave for home from Lottie Jane 4:00-5:00 p.m.
5:00 p.m.	TMEA Check in Lottie Jane	Dinner, Twin Towers	Dinner, Twin Towers	Dinner, Twin Towers	Dinner, Twin Towers	
6:00 p.m. 7:00 p.m	Orientation KEP Dinner, KEP Name Game. Me Boards, Lottie	Swimming at Mabee Pool (7:00-9:00 p.m.)	Lego Robots Bellovich/Harrington (6:00-8:00 p.m.) KEP M216	Career Panel: Meet some women from industry Faculty Study, McFarlin Library. 7:00-8:30 p.m.	Bowling Riverlanes Bowling Alley (7:00-9:00 p)	

Figure 2. Tulsa Mathematics Equity Academy—Week 2; July 7-19, 2002

	Sun, July 14	Monday, July 15	Tuesday, July 16	Wed, July 17	Thurs, July 18	Friday, July 19
7:00 a.m.		Rise-N-Shine	Rise-N-Shine	Rise-N-Shine	Rise-N-Shine	Rise-N-Shine
8:00 a.m.		Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers	Breakfast Twin Towers
9:00 a.m. 10:00 a.m. 11:00 a.m.		Number Theory Cairns (9:00-11:00 a.m.) KEP M216	LOGO Programming Farrior (9:00-11:00 a.m.) KEP L1/L2	Number Theory Cairns (9:00-11:00 a.m.) KEP M216	LOGO Programming Farrior (9:00-11:00 a.m.) KEP L1/L2	(9:00-11:00 a.m.) KEP M216, L1/L2
noon		Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Lunch, Twin Towers (11:30-12:30)	Luncheon with Etiquette Sharon Wilson ACAC President's Lounge 11:30-1:00 p.m. Leroy Fischer Speaker
1:00 p.m.		Rest Time 12:30-1:00 p.m. Astronomy Intro Aaron Coyner 1:00 p.m. KEP M216.	Rest Time 12:30-1:30 p.m	Rest Time 12:30-1:30 p.m	Rest Time 12:30-1:30 p.m	
2:00 p.m. 3:00 p.m.		Lego Robots Bellovich/Harrington (1:30-3:45 p.m.) KEP M216	Buckley—History of the NSA, History Channel video on NSA (1:30-3:45 p.m.) BAH 315	"Preparing to apply for College" Janna Roberson College Counselor, Cascia Hall School	Lego Robots Bellovich/Harrington (1:30-3:45 p.m.) KEP M216	Load luggage Prepare presentations of our work (1:30-3:45 p.m.) KEP
4:00 p.m.		Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Yoga/Tai Chi Dodie Nesbitt ACAC upstairs atrium	Welcome Parents Show our work Leave for Home KEP M216
5:00 p.m.		Dinner, Twin Towers	Dinner, Twin Towers	Dinner, Twin Towers	Prepare for Banquet	
6:00 p.m. 7:00 p.m	TMEA Check in Lottie Jane dinner 7:00 Marie Moran Battlebots	Movie Night in The Hut—"Midway"	Field Trip to Tulsa Astronomy Club observatory in Mounds, OK TU vans leave TU 7:15p.m. www.astrotulsa.com	Freaky Fashion Show Lottie Jane	Banquet, Mexicali Border, Downton, 6:30 p.m.	

Content
We have experimented with:

- Several short, self-contained topics.
- Four main topics, explored in general the first week, with students choosing one to explore in depth during the second week.
- All activities built around one central topic.

We have settled on the last approach. Any type of material that lends itself to individual and group exploration and experimentation is best. The students at our academy are not required to exhibit any scores or grades for acceptance. Therefore, the capabilities and backgrounds of the students are varied. Incorporating ways in which a student can progress at her individual pace, and feel successful, is important. Finding a way to learn about a subject through exploration and hands-on activities is the goal. The less one uses lectures to teach, the better it is.

We believe that an effective academy features mathematics that is accessible to students with an average grasp of the grade-level mathematics, but is outside what they will encounter in school. Also, it should give students a glimpse of the abstract structure of mathematics, the true "beauty" of mathematics that some of us don't encounter until well into graduate study.

In 2002 we developed a curriculum that worked well. Our focus was the study of cryptography. Students only needed basic Algebra, and yet we were able to study the integers modulo n, prime numbers, and some simple number theoretic results. We taught the students to program encryption and decryption schemes in Logo, an inexpensive, interactive language readily available to students at home. A history professor joined the academy faculty to discuss some of the history of World War II and women's roles in cryptology to give a historical context to the abstract mathematics. We intend to build even more recreational activities around encryption next summer.

A breakthrough moment came when we realized that from the inception of our academy we had been guided by the idea that if we could make mathematics relevant and interesting we could hook the students. By incorporating history into the academy and thinking about the contrast with mathematics, we heard the students tell us that for them the bigger problem is the difficulty of mathematics. We learned that one of the most valuable lessons we can teach our students is that "difficult" doesn't mean "bad". Having two weeks to keep nibbling at a difficult problem, with no threat of a test or grading, is a valuable gift to students who are products of a culture with so much instant gratification. When asked on their academy evaluation whether the level of mathematics presented was about right, two students gave the following replies:

> "The math was hard at first, but then I got the hang of it and started to like it."
> "Some was hard, some easy, you just have to stick to it and work your best."

Faculty/Staff
Students attend a summer academy at a university with the expectation of being taught by college faculty. While the material must be presented to the students on their level, the students desire the background and connections to other ideas that strong academic faculty can bring.

Some college faculty worry about their ability to connect with students of this age. It can indeed require a deep understanding of a subject and talent to distill approaches for younger students. Remain flexible and continue to search for meaningful hands-on activities to enliven teaching. In an academy setting, modeling the process of approaching open-ended problems may be as important as the particular information imparted.

Faculty must be willing to become friends with the participants. We use first names for all faculty and staff. Faculty should spend time going on recreational outings and getting to know the students.

For the 30 female students at the TMEA, we hire two Residential Advisors (RA's) to live with them in the dormitory. The RA's we have employed are female students at The University of Tulsa who are majoring in math or a math-related field. We try to limit our demands on their time during the day, only asking them to take the students to lunch. By giving both faculty and staff time off each day, we are able to reach the end of the academy without being over-tired ourselves. Personality conflicts have been minimal. The RA's are valuable in sharing their college experiences and career aims with the girls. RA's must be mature enough to ensure that the students will get enough rest, eat properly, and interact well together. RA's must deal with setting academy boundaries in a respectful way with parents

At one point, we tried inviting some of our best previous participants back as student mentors. That didn't work well for us, probably because we didn't spend enough time with that group separately, defining our expectations.

Use of Technology

For the first two years of the TMEA we invested in TI-82 calculators that we taught the students to use and gave to them to keep. While we still believe that females lag males in the use of technology, most of the students in 2002 already own a graphing calculator and are proficient at using a computer for word processing, creating presentations, and communicating. It becomes increasingly difficult to create a camp atmosphere, away from the distractions of friends and family when the students bring their own cell phones and have chat windows open during lessons in the computer lab. We have found that we need to instruct the students less in the use of technology, and more in the uses appropriate for the academy.

The University of Tulsa has a web based course content tool called WebCT. We use WebCT in our academy to post daily announcements, course handouts, and to host an academy discussion board and chat rooms. Students are able to access the site after leaving the academy and can maintain contact with each other and us. The community that we create in person at the academy can be preserved electronically. As a new academy is started, students from the previous academy are rolled-over into an alumni WebCT group.

A web site is maintained throughout the year for the academy (http://www.mcs.utulsa.edu/tmea). During the academy, we keep a daily journal by taking digital photos and having students write daily journal entries. Parents can keep informed of activities and see their daughters, and we all have a record of what we did. Students are given a CD-Rom with the website and additional photos taken during the academy to keep.

Recruitment/Publicity

The Oklahoma State Regents for Higher Education fund several academies for middle and high school students across the state. Starting in February, they maintain a website listing the academy offerings for the coming summer. They also send written materials to all Oklahoma public and private schools with a poster listing all the academies. Twenty-six of the twenty-eight students who took our evaluation last summer said they never saw the Regents' posters. Only twelve of those students visited the Regents' web site. Half of the students said they visited our website and saw our brochure at their school. Most of the students find out about the academy through a teacher at their school to whom we send application materials, a previous participant, or newspaper announcements that we get published.

Conclusion

In summary, we want to emphasize the following features for producing an inspiring summer mathematics academy:

- Plan the academy daily schedule well in advance.
- Allow reasonable and flexible time demands on all involved.
- Work with college faculty who enjoy being with the participants.
- Clearly inform both participants and their parents as to what is expected of each.
- Hands-on activities and embedding mathematics into a historical or other such context are helpful.
- Allow each participant to progress at a comfortable pace and experience individual success.
- Emphasize that it is okay to experience difficulty, and provide participants with problems that they can realistically solve on their own (perhaps with suitable support).
- Empower the participants with opportunities for them to teach others, e.g., their parents, and share some of what they have learned.
- Use the Internet, newsletters, and/or other resources to sustain the community of participants after the actual academy is finished and to build a network of students who are interested in mathematics.

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