Sooner Elementary Engineering and Science – *a model for after-school science clubs based on university and K-5 partnership*

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Abstract

Sooner Elementary Engineering and Science Clubs (SeeS) began less than four years ago at a single elementary school as an effort to bring more science education into our local elementary schools without increasing the burden on the school's teachers. Due to popular demand, the program expanded slowly at first, but is doubling to include eight schools in fall 2004. Experiences along the way, and the requests for expansion, resulted in the original model evolving through several iterations which we describe here. We don't believe there is one way to do after-school science clubs at the elementary level, but we do believe our experiences reveal lessons and pitfalls that can help guide other ambitious parents or community volunteers to have their own successful after-school engineering and/or science clubs.

Introduction

The formal goal of the Sooner Elementary Engineering and Science Clubs (or SeeS for short) is to interest or maintain interest of elementary children by making science and engineering come alive. We want to provide hands-on activities that support the state's academic standards, but are not limited by them. Also, the intent was to not add any additional burden on the teachers by using volunteers to carry out this enhanced curriculum. Thus we chose a format of informal, after-school science clubs. It is important to note that these clubs are not limited to any particular group of students (e.g. gifted, girls, or 4th grade underachievers). The program is available to any student on-site at the end of the day from pre-kindergarten to grade 5. We selected the elementary schools because (1) the originator of the program had personal contacts in one of these schools, (2) the teachers at this level are least prepared to teach physical science, and (3) recent developments indicate that many students are "lost" to science and technical careers by grade 4 or 5 (Sanoff, 2001). We did not set out to invent curriculum as there is an abundance available from conference proceedings, science education journals, the World Wide Web, and the local educational bookstore.

Evolution of the Model

The original model for SeeS had interested parents in engineering and science professions gathering after school to share their excitement with their children and their children's friends. In general, parents are willing to commit time and effort to such a program, especially once someone gets the program initiated. Many of the first school's parents took time off work to come once a month to do hands-on experiments with the elementary students. Several engineering students from the university were invited to the first meeting, primarily for "crowd control." Their impact was amazing. As parents, we are just Parker's mother or Grant's dad. However, the college students are "cool" (Rhoads, 2002). What we witnessed at this very first meeting was the elementary students tended to cluster around the college students and hung on their every word. Sometimes they even hung on their every limb, but the college students never seemed to mind.

Once the college students were recruited and became dependable helpers, the role of the parents shifted to PTA support or crowd control. One school has a full committee of parents that help each month with SeeS by gathering the needed supplies and attending the meetings. Other parental involvement ranges from general observation, to participating with their child, to helping with traffic control.

This development is a win-win situation since the elementary students look up to the college students and pay close attention to their words and actions. For the college students, describing engineering, science, or mathematics concepts at a kindergarten level is a teaching experience that develops their own understanding of a topic. Responding to questions surrounding the topic they are teaching further enhances their own learning. In addition, many of these university student volunteers love working with children and teaching the students topics that are of interest to them. The volunteers find immense satisfaction from the admiration shown by the elementary students. For the elementary students, the college students are the best form of motivation, as well as information when the children ask them what they are going to be when they grow up.

We have just adopted a new model to recruit college students. Though not many are needed for each event, you need at least a few every time. We started asking student organizations to adopt a school. Adopting a school means that you commit to having at least 4 volunteers to attend one SeeS event per month for the months of September, October, and November in the fall semester and February, March, and April in the spring semester. This commitment appeals to each group's requirement to do philanthropic work or community service. The College of Engineering is currently in the early stages of adopting several service learning objectives within its curriculum. Students majoring in physical sciences through the College of Arts and Sciences have no formal requirement for volunteerism, but many have a pre-medical application requirement for community service. And, of course, some students in both colleges certainly participate "just for the fun of it." Recently the meteorology student organization from the College of Geosciences contacted us regarding their desire to participate.

We recruit these organizations in much the same manner as we recruited individual volunteers in that a member of the SeeS coordination team attends organization meetings and discusses the SeeS objectives, time commitments, and program with the student members. The burden on an individual student volunteer is actually quite light. We only serve elementary schools in the same town as our university. For schools that are not within walking distance, we will arrange car-pooling or other ride. Since the activities are pre-selected and pre-stocked by the coordination team, volunteers only need to arrive at the school by 2:15 p.m. (30 minutes before the dismissal bell) select a station and read the instructions and background information associated with the activity there. From about 2:55 to 4:00, the volunteers guide the students through the experiments at their station. Finally, packing and cleaning generally takes less than 15 minutes. Therefore, the total time commitment per event per volunteer is about 1.75 hours on-site.

One major addition to the model that became necessary as we expanded to more elementary schools was a part-time coordinator. Initially, all coordination was done by a single faculty member. Even after the second faculty member joined forces, the expansion to more schools became very time consuming. Therefore, the student coordinator became necessary. Initially, this position was filled by a volunteer from the college's Engineers' Club. This is the overarching technical society in the college; all engineering students are *de facto* members of this club. Engineers' Club has two outreach positions, the Engineering King and Engineering Queen. As we went from one to three elementary schools, it became too much to coordinate this effort with the remaining duties associated with these positions. Thus, an assistantship position was created. This position has been filled by a student who was a regular volunteer and an undergraduate student in Industrial Engineering. He has since continued to graduate school and serves as the Graduate Teaching Assistant on the project. His position is funded from returned research incentive funds. The coordinator responsibilities include selecting new topics, researching and organizing the experiments associated with each topic, corresponding with the elementary schools, organizing, tracking and showing appreciation for the college student volunteers, attending and leading most of the SeeS events, and keeping statistics on the elementary student attendance. As a paid coordinator, he is not counted in the volunteer count.

Stimulating Interest or Obtaining the Out in Outreach

In addition to staffing the model, we needed access to K-5 children. The first elementary school was obtained in spring 2001 by engaging the principal and not only getting his buy-in, but his full involvement in the new program. He also supported a plea to the school's Parent Teacher Association (PTA) for enrichment funds to purchase expendables. The original funding allotted to the program was $250, of which less than $100 was spent through the first three events. That same principal agreed to a presentation to a state-wide educational meeting called the Winter Institute sponsored by the Center for Community and Educational Renewal at the University of Oklahoma (Rhoads and Hopper, 2001). Interest generated among attending teachers and principals resulted in two more schools added to the program in fall 2001. Funding for each of these two schools is provided by their respective PTAs and one school has a PTA committee dedicated to the facilitation of the SeeS program at their site. We maintained three schools until the fall of 2003 when the Norman Independent School District's student services coordinator came to ask us to consider "adopting" Norman's only Title I school. We agreed not only to add the school to our program, but also to pick up all expenses associated with the events at this school. The financial support for this new school is provided by a National Science Foundation Materials Research Science and Engineering Center (MRSEC) at our university. We now have a waiting list of schools that have requested to be considered. We are hoping to expand with the new model of technical engineering or science organizations adopting specific schools.

During the first year, a proposal was submitted to the local school district's non-profit foundation, the Norman Public Schools Foundation. This Foundation previously only funded teacher proposals; therefore, we were pleasantly surprised when they agreed to fund a year of the project including the development of a curriculum library of workbooks in various subjects such as kitchen chemistry, magnetism, electricity, weather, and physics. Next, an adjunct professor who is very involved with the Oklahoma State Society of Professional Engineers recommended that we apply to their educational foundation. Thus, our next funding source was the Oklahoma Engineering Foundation. Subsequent pools of funding have been obtained from returned research incentive funds. However, the most promising funding is coming from research centers, such as the MRSEC, and other grants that have an outreach requirement, such as the National Science Foundation's CAREER grants. We have the ability to provide access to a large number of local students for both of these outreach efforts. In addition to adopting the Title I school this year, the MRSEC has sponsored a number of our newer units on electricity, magnetism, and sound. The monetary funding for each event is not substantial. Except for units which need an initial capital investment, such as magnets for magnetism, the expendable costs per unit average less than $30 per month per school for an average monthly attendance of 50 students.

As was stated earlier, this is an after-school event. Advertising within a school is done through the school's parent newsletter, calendar, Back-to-School Night, and individual flyers. The elementary school is responsible for its own advertisement with supporting documents provided by the coordinator. This program is open to all children, so to get an initial idea of how many to expect a number of things have been done by each school. One school hangs a SeeS poster in their cafeteria and asks the students to sign it if they plan on attending. Two schools have the parents sign permission slips and return them to the school. Most schools include messages about upcoming SeeS events in their morning announcements.

Interest from the community at large is generated from newspaper articles, gifted resource coordinator reports, and our website; www.coe.ou.edu/sees. The website includes the event calendar, links to information on each topical area, and a Flash® animation introduction to the program. The SeeS logo was designed with the elementary students in mind. As part of an engineering multi-media course, directions to a graduate student were to design something fun, easy to reproduce by children, and with eyes that wink. The logo is given here in 2 dimensions in Figure 1, but to get the wink, one must visit the website.

Figure 1. SeeS logo

Events

The SeeS model consists of one session per month per school for three months each semester. Due to ramp-up time for college students and settling in time for the elementary populace, we don't start in a school before the middle of September, approximately one month after the public school year here begins. Each month's session is organized around a theme or topic (e.g. flight physics, acid-base chemistry, magnetism, electric circuits). About three concepts or words related to that theme are the target learning objectives for the afternoon. Volunteers arrive at the school about thirty minutes before school is dismissed to assist the organizers or coordinator with set-up.

When the dismissal bell rings, participating elementary students flood the cafeteria or gymnasium, eager to get signed in, to find out what the topic is, and to dive into the experiments. In the early semesters, students rotated at will through at least five of seven or eight stations. Each student had a "punch card" which the volunteer at the stations they engaged in would mark. Five marks entitled the student to snack. While this allowed the students the freedom to bypass activities that didn't appeal to them, it also meant that a volunteer had to explain the station and answer the same questions 40 different times. Feedback from volunteers indicated that they would prefer to have students arrive in groups. We also had occasional difficulty with the free-rotation model from students wandering off. In some schools, the community after school program is set up in the opposite end of the room and students enrolled in that drifted back and forth. The evolution of the student rotations now includes assigning students as they check in to one of four color groups with stickers. Each group starts at a different station and they rotate en masse with a signal from the coordinator.

Another recent development is the incorporation of "The Clap." A common class attention grabbing technique is for the teacher to clap loudly in a tricky rhythm which the children then echo. The clap is used to focus attention on the coordinator for a one minute welcome and introduction of the day's activities. It is also used to signal the time to change stations.

At least 80% of our activities come from published sources, either on-line or from the educational supply store. We do occasionally develop our own activities and we freely modify the published activities to adapt them to our population. For each theme, we prepare a parent handout that is distributed at the end of the session. This handout provides parents with a brief description of the day's activities, as well as a list of the resources used or similar ones consulted for the unit. Parents are encouraged to discuss the experiments, and hopefully try some new ones, with their children.

Lastly, alignment of the state of Oklahoma's Priority Academic Student Skills (PASS) objectives is an added benefit to this outreach effort. The physical science PASS objectives are presented here, but note that each set of grade levels also has similar objectives for the science processes and inquiry and for earth/space science. Those have not been included here but can be found along with these physical science objectives at http://www.sde.state.ok.us/home/defaultie.html.

Grades 1 – 3 (excerpted from the above website)

The student will engage in investigations that lead to the discovery of the following concepts:

■ Properties of Objects and Materials
- Objects have properties that can be observed, described, measured, and recorded.
- Materials exist in different states – solid, liquid, or gas.

■ Position and Motion of Objects
- A push or a pull causes something to move.
- Motion and interaction of objects can be observed in toys and playground activities.
- Sound is produced by vibrations.

■ Light, Electricity, and Magnetism
- Some materials conduct electricity.
- Magnets attract and repel each other and certain other materials.

Grades 4 – 5 (excerpted from the above website)

■ Properties of Objects and Materials
- Properties of objects can be measured using tools such as rulers, balances, and thermometers.
- Changes in properties can be observed, described, measured, and recorded.
- Changes in temperature affect the properties of materials.

■ Position and Motion of Objects
- The motion of an object can be described by tracing and measuring its position over time.
- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

■ Heat and Light
- Heat moves in predictable ways from warmer objects to cooler objects.
- Heat can be transferred or produced by friction, conduction, and light absorption.

Metrics

Some of the best testimonials come from the children themselves. When you come home and get the thumbs up sign from children who have attended a SeeS event, you have succeeded. Being called into a senior professor's office and told that his grandchildren were extremely disappointed that SeeS wasn't a daily event is more anecdotal evidence of success. Lastly, getting picked out by a child at the local grocery store and called the "science lady" is a satisfying feeling. However, we continue to track attendance as a measure of our influence. Starting last spring, we began tracking not only number of students attending, but also gender and grade level. In the spring of 2003, we touched 209 students through 6 events for an average of 34.8 students per event. During the fall of 2003, we have touched 297 students in the 8 events held to date for an average of 37.1 students per event.

The gender and age distribution statistics are very interesting to note. In having worked with this program for almost three years, it has become obvious that the total number of students attending SeeS events are more heavily weighted toward the lower grades. This point was made in the 2002 paper presented by Rhoads. Moreover, additional data has been gathered and the point is once again confirmed; gender distribution becomes more inequitable and total attendance decreases with increased grade level. The bar graph portion (and left axis) of Figure 2 shows the percentage of girls attending SeeS events for the spring 2003 time period of the students reporting their gender and grade level. In addition, the decreasing total attendance for each grade level is included in the line graph portion and right axis.

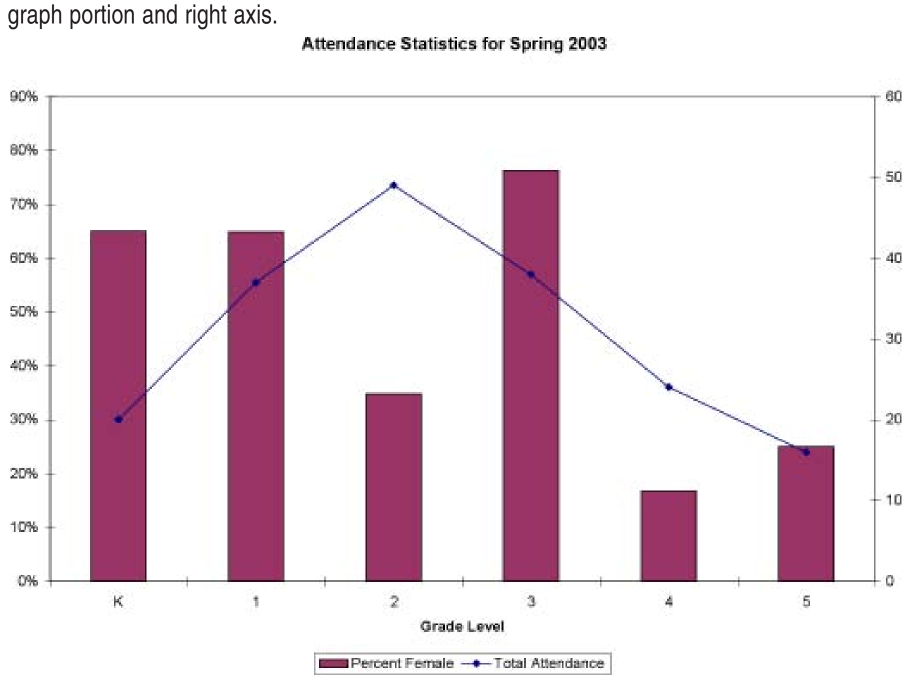

Figure 2. Attendance statistics from spring 2003 of elementary students reporting both grade and gender

Beginning in the fall of 2003, we began a serious effort at gathering all gender and grade level information at each site. The statistics presented here do not include our new Title I school since their administration has chosen specifically to recruit, 3rd, 4th, and 5th grade girls and all-day kindergarten students. The merged statistics from the 2 semesters appears to show a trend of achieving gender parity. However, we know that one site has a conflict of honors chorus during the SeeS time, which draws heavily on 4th grade females. In general, there are too many such conflicts to draw conclusions on cause and effect. This trend toward parity is shown in Figure 3.

The program depends on the volunteer effort of many engineering and science undergraduate and graduate students. There were 67 spring and fall 2003 college student volunteers. Therefore, we averaged 3.9 volunteers per event. It is not unusual for students to repeat volunteering once they have been convinced to attend one program. Figure 4 is a graph showing the number of SeeS events an individual attended over this same period. The graph shows that over 20 volunteers went to 2 or more SeeS events with one volunteer coming to 6 events. One incentive that we have for college students to volunteer is the receipt of a SeeS t-shirt after volunteering at 3 SeeS events. This helps with our advertising and college students love "free" t-shirts.

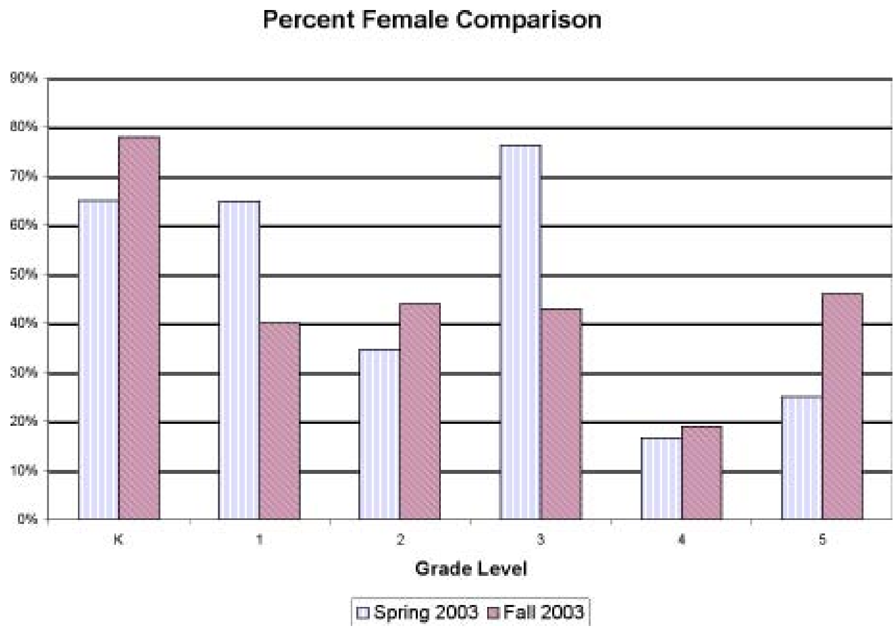

Figure 3. Percent Female Comparison from spring 2003 to fall 2003

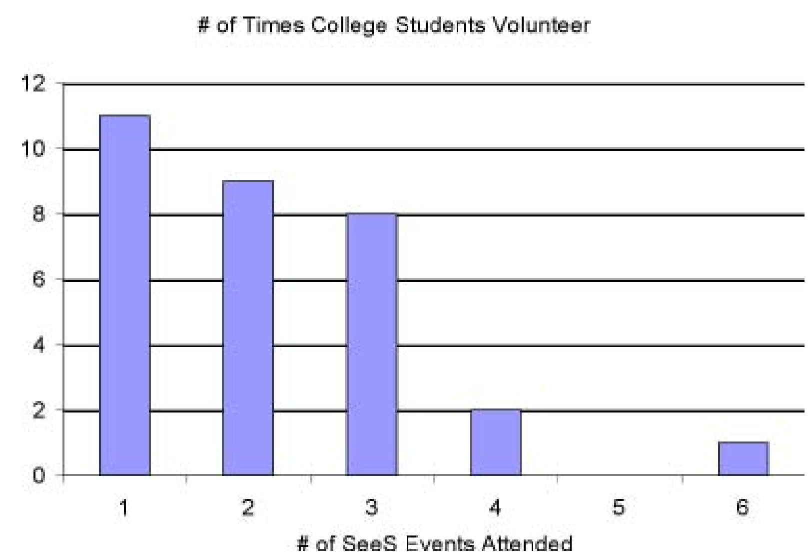

Figure 4. Average SeeS events per volunteer over a 2 semester period

Conclusions

The SeeS model has evolved from a single school parent-based event to a service learning opportunity for university students in eight different schools. Hands-on curricula exist and are readily available at local educational bookstores or on the World Wide Web. Engaging science does not have to be elaborate, extravagant or expensive. The scientific curiosity and engineering ingenuity of eager impressionable young students can be affected with dedicated staff, caring parents, enthusiastic collegiate volunteers, and minor funding. We end every meeting with our slogan "We hope to SeeS you next month!" and we mean it; not only by laying eyes on them next month, but also by seizing their interest in science and engineering.

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