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Paper Session III-B - A High-School Level Summer Space Education Seminar

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ABSTRACT

The use of space as a basis for a week-long seminar aimed at high-school teachers and students has proven successful. This seminar includes academic, demonstration, and activities to show students and teachers how high-school level mathematics and science is used in the space world. We have found this program to be an excellent motivator for students and teachers and enhances their normal learning activities. This paper describes the goals, mechanics, and activities of the program. Evaluation results are also discussed.

SEMINAR GENESIS

The Space Education Seminar is an outgrowth of a program started in the College of Engineering at New Mexico State University to bring high-school teachers and students on-campus to interact with the engineering faculty and students. This program was initially funded by industry and involved the local high school teachers and students from New Mexico and El Paso. The seminar was to be structured around a residential one-week program on campus that involves teachers and students for an entire day and evening for one week. The initial seminar focus was shared among several departments on a rotating basis. The past two summers, the seminar has included a week dedicated exclusively to space-related activities which was administered by the New Mexico Space Grant Consortium (NMSGC) office.

SEMINAR GOALS

The seminar’s first goal is to show both the students teachers how what they are learning in high school applies to college-level engineering studies and professional engineering activities. High school students and their text books are often not clear on how the concepts relate to the real world. This motivation is also needed for the teachers who often come from an education background and not a technical background and therefore
are not clear on the usefulness of many concepts. A secondary goal becomes to show the students and teachers how the space-related concepts fit into their curriculum and can be accessible to the students. This would provide motivation for academic excellence and in interest in entering college in a technical area. We also developed a goal of de-mystifying the process of applying to college and for financial aid. From our surveys, we have found much confusion about these processes among potential students.

SEMINAR MECHANICS

1. Teacher and Student Selection

Teachers are invited each year to nominate themselves for attending the seminar with a student. The mailing list for the solicitation covers most of the state of New Mexico and many of the adjacent Texas school districts. The teachers are told to nominate the students themselves based on the criteria of student excellence, first-generation status, and sex. We encourage teachers to nominate female and minority students but do not make that a requirement. Teacher-student pairs are selected based on available funding, non-attendance at previous seminars, content area from which they teach. Luckily, each of the past two years we have been able to service nearly all those who have applied. Each participant receives a stipend for the week: teachers receive $200.00 and students receive $50.00. The mix of participants in the program during the summer of 1992 was as shown in Table 1. The mix of student participants matches the state ethnicity profile even though no explicit attempt was made for balance.

2. Local Arrangements

We arrange to have the students and teachers who do not commute from home live in the campus dormitories. The students obtain an insight to college live in this way. Local students and teachers are allowed to commute from home. For those who reside on campus, the program pays for the housing and gives each resident a meals stipend which they are allowed to spend in any way they see fit. The residents are also paid travel expenses from their homes.

3. Support Staff & Infrastructure

The New Mexico Space Grant Consortium staff handle the local arrangements, preparation of materials, and coordination of instructors. Many of the materials used were developed for the summer program, for our normal outreach programs, and for use on campus and are housed in the NASA/FAA Regional Teacher Resource Center (TRC) which is co-located with the NMSGC. The teachers also receive a tour of the TRC and a chance to plan its use as a support for themselves when back at their schools.
Table 1. Participant Backgrounds

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Teachers</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>% male</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>% female</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Ethnicity</td>
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<tr>
<td>% Hispanic</td>
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<td>83</td>
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<td>13</td>
</tr>
<tr>
<td>% Asian</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>% African American</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

New Mexico Hometowns
- Las Cruces: 12
- Albuquerque: 5
- Other: 25

Texas Hometowns
- El Paso: 2
- Other: 4

CURRICULUM CONTENT

Due to our principal goal of applying high-school level concepts to space, the curriculum is structured so that nothing more than high-school level mathematics and science are required to work through the seminar lessons. This does not mean that the lessons do not stretch the knowledge base of the students and teachers. Rather, we designed activities that would be a challenge yet still accessible to the students and teachers. The participants had three activity types: in-class presentations, hands-on demonstrations, and evening activities. The content of each is described below.

1. In-class Presentations

The in-class presentations were primarily aimed at new material from that normally covered in high-school texts. The lessons which we have to draw on as as follows:
   a) physics of model rocket flight to show the forces acting, the equations of motion, and a computer-assisted component selection for the goal of flight to a specified height,
   b) procedures and computations to predict space shuttle visibility near sun rise or sunset,
   c) probability and random walks,
   d) prediction of the altitude and azimuth coordinates to find a geostationary communications satellite using trigonometry and spherical angles,

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e) circuits and calibration for measuring temperature and then telemetering the result,
f) orbital mechanics using high school algebra and trigonometry,
g) the rocket equation to determine propulsion needs.

We also have a mathematics review to provide background for some of the lessons.

2. Hands-On Demonstrations and Industrial Participation

The matching of theory with practice is required in education. Various activities to provide hands-on experience were provided. Also, guest speakers and tours from local space assets were made part of the program. Hands-on demonstrations include:
- the use of the NMSU swimming pool for underwater construction to simulate space construction techniques using large PVC pipe and fittings,
- the flying of model rockets and verification of altitude reached by triangulation,
- the construction of electronic thermometers from parts obtained at Radio Shack, and their calibration and usage to measure participants temperature,
- kinesthetic chemistry to teach atomic interactions by using body movements.

Industrial participation has included
- presentations by NASA and McDonnell-Douglas engineers,
- tours of the NASA White Sands Test Facility,
- tours of the Sun Spot solar observatory.

We also make use of the International Space Center museum and IMAX theater.

3. Evening Activities

In the evening, the teachers and students are split into their respective groups for individual activities. The students are assigned to teams to play the simulation game Moonbase which simulates the activities of a lunar colony. They are also given movies to watch and time to work on completing their model rocket kits. The teachers are brought together to discuss issues of how to work through introducing new concepts and material into their classrooms.

EVALUATION AND FOLLOW-UP

Two forms of evaluation are used in the seminar: immediate and follow-up. The immediate evaluation critiques each activity of the week, both curriculum, arrangements, and activities. The follow-up seeks to assess the impact of the program during the school year. The immediate evaluation has been used to fine-tune the content and presentation methodologies. This is especially important in making the in-class presentations more interactive and at the proper level.

The follow-up has show some interesting conclusions. The follow-up data is in-
complete because it is still being gathered, however, the preliminary results show that the seminar is a good motivator to the students and has a definite positive impact on their educational goals. The teachers also indicate that many of them have found direct application of the material the following semester into their classrooms. The teacher surveys also show that to reach everyone at some level, a variety of teaching styles and experience must be presented.

LESSONS LEARNED

Programs of this type are always developing and evolving from year to year. From our perspective, we have learned some valuable lessons for others considering establishing similar programs. The major lesson learned is the obvious one: the success of the program is directly proportional to the preparatory work. Our second year went much smoother than the first primarily because we started working earlier in the year to organize and plan.

One lesson which funding agencies seem to ignore is that successful programs need dedicated support staff. We hire a full-time coordinator for approximately four months to process paperwork and purchase orders, facilitate arrangements, and prepare materials. This is a non-instructional expense that is worth the investment.

The concept of pairing the students and teachers has some definite advantages. The students are very helpful in showing the teachers how to work the computers in the lab. There is also a subtitle shift in the interactions from a hierarchy teacher-student relationship to an equal partnership of co-learners.

Many college-level faculty do not have an appreciation for the background, teaching styles of the pre-college teacher. We made the mistake of becoming too content oriented in the beginning. The seminar taught us to slow down, take smaller steps, and keep everyone going in the same direction. While it is good for the students to see some of a college-level teaching style, it can also overwhelm the students and teachers both. Coupled with this is the fact that college-level teachers will usually move through the material at too quick a pace. We have found that by structuring the "lectures" with built-in working of examples keeps everyone on pace and allows for the students and teachers to immediately exercise the concepts being presented and clarify misunderstandings.

Many high-school teachers do not have a good understanding of the background which college departments in the sciences and engineering expect of the students. These expectations are usually more demanding than the college baseline entrance requirements, especially at state schools. We have purposely invited administrators to the seminar to tell the teachers and students what the current expectations are. We also invite administrators to the seminar to explain the process of applying for financial aid and answer ques-
FUTURE TRENDS

We expect his program to grow and continue. As the program grows, we expect that the primary driver for the program will be the matching of the content areas with the emerging mathematics and science standards being developed for the pre-college educational community. The best help university faculty can be to the pre-college educational community is act as a mentor for teaching the teachers how to design new and innovative curricula to meet the standards and expend the envelope of knowledge of the pre-college teachers. These partnerships are the direction which the federal support agencies will be looking for in funding educational programs. Colleges and universities need to build good working relationships in the science and engineering areas with their pre-college clients now.

ACKNOWLEDGEMENTS

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