

Yerkes Astrophysics Academy for Young Scientists (YAAYS)

Project Summary

The Yerkes Astrophysics Academy for Young Scientists (YAAYS), originally entitled “SEEing the Universe”, will create engaging and scientifically compelling out-of-school-time (OST) experiences for grades 3-8 students in the Geneva Lakes area in southern Wisconsin, including students with vision and hearing disabilities. It is a partnership among astronomers, educators, and engineers associated with the University of Chicago's Yerkes Observatory, Geneva Lakes area schools and school districts, the teacher education programs at George Williams College Aurora University, Wisconsin Center for the Blind and Visually Impaired (WCBVI), National Federation of the Blind (NFB), Wisconsin School for the Deaf (WSD), local business and civic associations, Adler Planetarium & Astronomy Museum, the Science Museum of Tokyo, Hands-On Universe (HOU) at Lawrence Hall of Science (LHS), and the Astronomy Resources Connecting Schools (ARCS) teachers of an Illinois Mathematics and Science Partnership.



Intellectual Merit of YAAYS: Students will use many of the same tools and techniques scientists use to explore the physical Universe by building scientific instruments (telescopes, cameras, and spectrometers), using them to make quantitative measurements, and conducting observing projects. Hands-on OST activities will increase students' understanding of light, matter, energy, wave motion, measurement, and data analysis. By participating in activities at Yerkes Observatory and interacting with University of Chicago research scientists and engineers, they will be inspired to relate their activities to real-world models and the rich history of astrophysical exploration conducted at the Observatory. Scientists will learn how to better communicate with students, teachers, and community members. Formal educators in schools and informal educators at Yerkes Observatory, the Adler, and Science Museum Tokyo, will increase not only their knowledge of and strategies for teaching science, technology, engineering and math (STEM) disciplines, but also enhance learning experiences for all students by using tactile, visual, hand-held models constructed for and by students with sensory disabilities, and by involving students physically, socially, and cognitively (Blamires, 1999).

Broader Impacts of YAAYS: YAAYS will catalyze the educational, scientific, and business communities as follows: Strengthen the growing network of students, teachers, and scientists linked through Yerkes Observatory. Bring to the consortium of school districts the resources of George Williams College for teacher preparation and Masters Degree Programs. Break down barriers that discourage students who are deaf or blind from participating in STEM activities. Enhance the roles of the Wisconsin School of the Deaf and the Wisconsin Center for the Blind and Visually Impaired in the community of science teachers and learners in southeastern Wisconsin. WCBVI and WSD are the state outreach centers for blind and deaf education. Enable the National Federation of the Blind to inform teachers on strategies and techniques that enhance the learning of students with vision impairments. Increase investment of local business and community organizations in supporting STEM education. YAAYS will facilitate the transformation of the observatory's focus from pure research to an informal science education organization.

Project Description

1. Rationale

Overview

Astronomy is a field that attracts and excites even the youngest students, and it offers many opportunities to learn about basic concepts of physics, chemistry, and mathematics. It is an excellent nucleus for out-of-school-time (OST) experiences that complement in-school programs, inspiring and motivating students to pursue STEM studies and careers.

Yerkes Astrophysics Academy for Young Scientists (YAAYS) builds on extensive experience by the key personnel with OST and teacher professional development programs based on collaborative relationships among research scientists and educators in schools and informal science education centers (ISECs). Teachers in grades 3-8 will play a central role in recruiting students into the program and coordinating in-school and out-of-school learning. YAAYS will strengthen their understanding of STEM content and processes and expose them to new and varied instructional methods in ways that have positive impacts on their students. They and their students will become members of a collegial learning community that includes scientists and expert teachers in their communities and around the world.

YAAYS will show how this partnership model can be effectively established and sustained in a small-town/rural environment. The evaluation plan will carefully study all phases of this work, so that early formative evaluation can be used to re-direct and guide the partnership to success. Yerkes Observatory, a historic astrophysical research institution which has been an integral part of the community since 1895, is transforming into a science education center serving the Geneva Lakes area and enabling access to STEM resources not otherwise available to individual school districts. The partnership includes teacher education resources, programs, and conference facilities at George Williams College. Local businesses and civic groups will play key roles in broadening students' understanding of the fundamental role STEM disciplines play in the world and in building support to extend/sustain the program when NSFAYS funding closes.

A special feature of the YAAYS community is that it includes schools and institutions serving students who are deaf or hearing impaired and blind or visually impaired. Collaborations with educators and students in this community will lead to the generation and documentation of new instructional methods and strategies that enhance accessibility for students with sensory disabilities. The YAAYS program will play a role in integrating disabled people into OST programs by giving children the education they need to compete and by demonstrating to non-disabled children that disability is a natural aspect of life. Ableism provides a useful perspective. Students with disabilities need to have access to the same opportunities provided to non-disabled children (Hehir, 2003). YAAYS will play a vital role in building learning communities in which disabled children are included physically, socially, and intellectually.

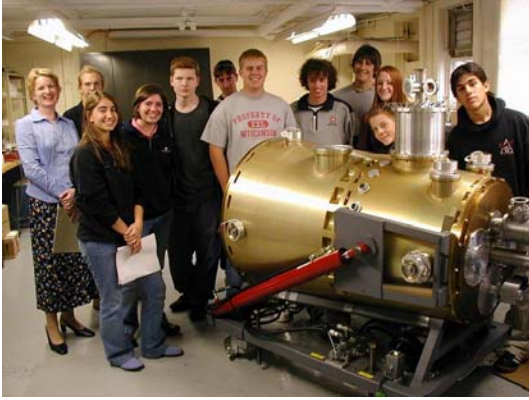
Fostering the highest quality STEM learning will be a key to succeeding in the globalized economy of the 21st century. If we want our youth and our communities to succeed, we need to invest wisely and immediately. In the internet age, it is easy for scientists and businesses to reach around the world, but we must not neglect to cultivate our local communities in the process. YAAYS will provide a model for how to accomplish these goals in a small-town/rural environment.

Background

YAAYS builds on almost two decades of educational outreach partnerships between research scientists at The University of Chicago's Yerkes Observatory and K-12 educators, many catalyzed and supported by the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA). These activities have been implemented during out-of-school-time (OST) with students, beginning with our work within CARA (the Center for Astrophysical Research in Antarctica, an NSF Science and Technology Center). Yerkes has become a center for professional development for teachers, for example through ARCS and HOU. The University has recently decided to transition the observatory from a facility primarily devoted to research to one dedicated to science education. This represents an opportunity and a challenge.

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In many senses, the observatory was the birthplace of modern astrophysics. It has a rich history of scientific accomplishment extending from the 1890's through the beginning of the 21st century. We know from experience that the observatory, its history, and its telescopes can be potent tools for stimulating excitement about science and technology. The challenge is to create a model for ongoing operation that honors its tradition as a leading scientific institution and its 110-year history within its small-town community in Williams Bay.



YAAYS builds on a very strong extended network of scientists, educators, and organizations and a solid base of proven curricular materials and activities. Yerkes has been increasing its outreach to the immediate Geneva Lakes region, primarily through funding from the Geneva Lakes Environmental Education Foundation. These efforts have created an enthusiastic core of high-school students and teachers. It makes sense to expand these efforts to elementary and middle school in order to engage the students at an earlier age, giving them more time to 'grow into' the possibilities and opportunities at the observatory.

A National Science Foundation Academy for Young Scientists (NSFAYS) program has resonated positively with all of our partners and is attracting, energizing, and consolidating the local support base needed to establish a program that fully serves the local/regional pool of students and teachers. YAAYS will provide an opportunity to discover how to transform a "grass roots" collaboration of a small group of scientists and educators into a regional hub that can more effectively serve our local and regional communities. We feel that in the process, we can also succeed in enhancing the intellectual reach of Yerkes-based outreach efforts to an even larger regional, national, and international community. The support of community stakeholders for the preparation of this proposal has been extremely encouraging as evidenced in their resounding letters of support and commitment.

Theoretical Basis

Amateur astronomy, including activities as diverse as telescope building and variable-star observing, is an OST experience that has long provided an entry point into astrophysics and other STEM fields. Today, an even richer array of possibilities for inquiry-based learning has been created by on-line astronomical databases accessible not only to professional astronomers but to anyone with a computer and a connection to the internet. Although astronomy is rarely included in the formal curricula of schools, our previous experiences with students and teachers have shown that it can not only be a powerful way to excite students about learning but also gives them motivation and opportunity to employ a wide range of other scientific and mathematical knowledge. Astronomy is also interesting and accessible to people of all ages, providing opportunities to link younger and older learners and to maintain continuity of involvement across grade levels.

The concept of an "educational pipeline" is outdated, with connotations of knowledge being added like doorknobs at a pre-determined time and a finished product rolling complete into the world at the end. We believe that a more appropriate metaphor is a network in which third graders and research scientists are just learners with different histories of experience and in which information flows freely and profitably in all directions. All "nodes" (students, teachers, scientists, families, community members) can contribute value. All kinds of "links" (direct and indirect personal contact, formal and informal writing, speech, and visual expression) add value. Students will be members of an active and supportive community of learners. Program events will include their families and create forums for community pride. YAAYS will explore how to systematically involve partners to use OST programs to foster and sustain interest in STEM pursuits using astronomy as a focus in a rural and small-town community that has itself been an integral part of the birth and growth of modern astrophysics.

Project Model

Our model for the use of OST to engage and sustain students in STEM learning builds on a regional network of scientists, parents, community members, and educators. It comprises (1) a diverse group of stakeholders, (2) a robust plan for teacher involvement and professional development, (3) an exciting and varied program of OST activities, and (4) a plan for developing support after the NSFAYS funding.

- 1) Stakeholders include students, scientists, formal and informal education educators, a consortium of school districts, centers and institutions serving students who are deaf or hearing impaired and blind or visually impaired, a university specializing in education, a research university, parents, businesses, and local community groups.
- 2) Teachers in local schools will receive training in astrophysics, history of astronomy, and use of hands-on activities, and professional development reflecting best practices informed by educational research. They will recruit students and conduct OST sessions.
- 3) OST activities will include hands-on experiments in schools, activities at Yerkes Observatory, trips to The Adler, Science Liveshow UNIVERSE with the Science Museum Tokyo, field trips to other STEM-related venues in the Geneva Lakes area, and two summer institutes conducted at George Williams College and Yerkes Observatory.
- 4) In addition to NSF and NASA grants, some of our previous OST activities have been supported by grants from local groups. However, to achieve a continuing program, additional support will be required. The University of Chicago's plan for the future of Yerkes Observatory includes a revenue stream for operation of the observatory, but community involvement will also be essential. The stimulation and deepening of relationships among stakeholders fostered by YAAYS can greatly enhance the prospects for success.

Our model addresses the following needs: (1) providing enriched STEM resources in an area with many small independent school districts, (2) accessibility for a diverse population including students from a range of economic circumstances and those with sensory disabilities, (3) reaching a larger population of students, and (4) sustainability of STEM OST programs over time scales sufficient to have a lasting impact on student career choices.

2. Goals and Objectives

Our goals and objectives directly address NSF STEM education objectives by developing out-of-school-time student programs. Our approach connects educators to a network of institutions with expertise in STEM disciplines, creating a community of learners. We will build sustainable OST programs that connect with a larger community to strengthen the skills students need to succeed in an increasingly globalized economy. Our goals are also in line with the Wisconsin Academic Standards in Science.

- Strengthen STEM learning through inspiring OST programs for elementary and middle-school students, including students who are blind or visually impaired or deaf or hearing impaired.

Objectives:

Create programming at Yerkes Observatory during OST for students in grades 3-8. The program will use astrophysics to inspire students to learn basic concepts of science and math.

Connect students to a global learning network of peers, teachers, and STEM professionals that can help them succeed in the global economy of the 21st century.

Learn how to make STEM learning experiences more accessible for blind and deaf students. Make this knowledge broadly available to formal and informal educators.

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Enlist support from local STEM professionals to broaden the YAAYS program to include linkages to other disciplines of science, technology, and engineering.

Excite young students about STEM studies in high school, college, and in careers.

- Provide enhanced opportunities for professional development for teachers in Wisconsin and Illinois.

Objectives:

Engage 20 local K-8 teachers in training sessions that increase their STEM content knowledge and pedagogical content knowledge.

Engage YAAYS teachers in enduring professional learning networks such as ARCS and HOU.

Provide teachers with opportunity for graduate level credits and/or Masters Programs.

- Utilize Yerkes Observatory as an informal science education center with strong local community support; a robust, extended learning network of scientists, educators, and students; and regional, national, and international impact and prominence.

Objectives:

Raise financial support for ongoing OST programs that serve the needs of local students and teachers.

Build a local base of teachers, students, and citizens who can help connect Yerkes with its broader learning community.

Increase the pool of scientists participating in Yerkes outreach activities. Include both astrophysicists and STEM professionals from other disciplines, such as astro-biology.

- Gather data, conduct research, and spread the lessons learned from the YAAYS model to a national audience.

Objectives:

Publish and report in educational and professional organization meetings and journals.

Work with NSFAYS Research and Evaluation Center.

Student Outcomes

Students will express a higher interest in pursuing careers in STEM related fields as a result of their participation in YAAYS.

Student performance in STEM disciplines will increase as shown by school district and state assessments.

Students will invest OST on STEM activities as measured by their participation in YAAYS.

Students will cooperate and collaborate as members of a team of professional learning communities that includes peers, parents, scientists, community members, business and industry as evidenced through journal entries, collaborative projects, or community presentations.

Students will value human diversity as they collaborate with peers and professionals who are blind or visually impaired, deaf or hard of hearing.

Students will be valuable contributors to enriching and enhancing program activities through generating and sharing ideas with collaborating teams.

Students will be more prepared for high school STEM courses as a result of participating in YAAYS as compared to non-participants.

3. Project Design Overview

Partners:

Partnerships for YAAYS include: University of Chicago Yerkes Observatory, Consortium of Geneva Lakes Area Schools; WCBVI; WSD; George Williams College Aurora University; Geneva Lake Environmental Agency; Geneva Lakes area businesses and industry, with leadership provided by the Williams Bay Business Association; Adler Planetarium & Astronomy Museum; Science Museum, Tokyo; Astronomy Resources Connecting Schools teachers, and Hands-On Universe teachers.

Overview: During 2007 and 2008, more than 100 students in grade bands 3rd 4th 5th and 6th 7th 8th will participate in more than 150 hours of out of school time programming in the STEM disciplines as applied in the study of astrophysics, using the resources of Yerkes Observatory and other partner institutions.

Teacher Professional Development:

Teacher training and professional development will be managed by our college of education partner, George Williams College Aurora University. This professional development will include studies in educational research, action research, and application of models for universal design for teaching and learning; collaborative learning; and learning cycle theories. Astronomy and physics content learning, including the nature of science as a human endeavor within an historical context, will be the responsibility of the scientists, historians, and astronomy educators at Yerkes Observatory.

Student Activities:

Students will be involved in after school programs, field trips and observing sessions, and summer camps. These will occur in several venues. The activities may take place at their school or at the observatory or a combination of both, depending on the decisions made during the planning phase in the fall of 2006. At least once each semester, students, their families and their teacher will attend an evening observing session using Yerkes telescopes. Once each school semester, students will go on a field trip to The Adler by taking the Metra train from nearby Harvard, Illinois. Each Adler field trip will feature a different gallery tour and sky show. Parents will be invited to attend these field trips. Once each month, on the 2nd Saturday of the month, students will be invited to Yerkes Observatory or one of our partner institutions for a virtual field trip to the night skies across the ocean in Japan; this is the Science Liveshow, UNIVERSE, from the Science Museum Tokyo. During the duration of the program each teacher and her/his students will have the opportunity to participate in the delivery of Live Observations from Yerkes Observatory for the Science Museum Tokyo audience. During the summer of 2007 and again in 2008, Yerkes Observatory and George Williams College will offer a summer camp experience for YAAYS teachers and students, culminating in science presentations by learning teams under the Pavilion on Geneva Lake at GWC.

Materials and curricula to be used:

Our program materials will begin with such existing modules as Lawrence Hall of Science GEMS Guides: Earth, Moon and Stars, Uncle Al's Star Wheels, Oobleck; Universe at Your Fingertips and the Active Astronomy Kit available from the Astronomical Society of the Pacific; observing resources such as Learning Technology's Sun Spotter, Coronado's PST Solar Telescope; Meade and Celestron, and Orion telescopes; Starry Night software, and Hands-On Universe Explorer, image processing software, and curriculum. These program materials will provide a basis but we will also work with our scientists and educators to create experiences and materials that are responsive to the interests of our participating young scientists and their teachers.



Considerations for students who are blind or deaf or sensory impaired: Resources will be evaluated and enhanced to meet the needs of students who are deaf or blind. Technology that will be especially useful will be the Thermoform Graphics Machine that uses Swellform paper to create tactile images of astronomical objects. We have experience with this technology during our participation in the SEE Project with DePaul University and the Wisconsin School for the Blind and Visually Impaired, and distributed through You Can Do Astronomy.

A sixth grade student who is blind wrote: “My Experiences: When I first entered the dome I was very excited. I got to feel the telescope and see how tremendously huge it was. Then we started observing the planet Saturn. There are several different things you have to do correctly to take a picture of Saturn. The telescope, the dome, and the floor have to be set correctly. They can be set correctly simply by using a paddle. This is a remote control with about ten buttons. After all these things are set correctly you have to take a picture of the planet as well. You do this on the computer. A lot of the time the pictures aren’t centered but when they are it is wonderful. You can only take pictures when it is a clear day (night). All these jobs take a lot of team work. Taking a picture takes a lot of patience but after it is completed you know your efforts are worthwhile.”

Scientist Participation: Astrophysicists from University of Chicago, a historian of astronomy, and other professional astronomers are committed to participate in YAAYS. These scientists will bring to the students and their teachers resources that are historical representing astronomy as a human endeavor, and technological with the telescopes at Yerkes Observatory and the resources of 21st century astronomical endeavors such as Hubble Space Telescope, Sloan Digital Sky Survey, and the Stratospheric Observatory for Infrared Astronomy.

Local STEM professional participation:

We are looking to our community, business, and industry partners to offer field trips and/or speakers who represent the STEM applications in the everyday world of the Geneva Lake communities. For example, the Fire Department of Williams Bay has an infrared camera which they use to detect temperature changes and visual heat difference in burning buildings. The Geneva Lakes Environmental Agency will organize lake studies to illustrate the physical properties of heat exchange in lakes on such a planet as Earth.

Development of community support:

The Village of Williams Bay, the Lions and Lioness Clubs of Williams Bay, the Business Association of Williams Bay, the Geneva Lake Association Environmental Foundation; the Geneva Lake Environmental Agency, Yerkes 21, and the Williams Bay Fire Department have all stepped up to support this proposal. We will call on these various groups to lead the effort to build support for YAAYS with their counterparts in participating communities. The Village of Williams Bay has the deepest investment in the success of this program since Yerkes Observatory and George Williams College Aurora University are in the Village. We will rely on the WSD and the Wisconsin School for the Blind and Visually Impaired to communicate with their network of institutions and community partners. We think that the right way to go about the recruitment of support is to let our closest community partners take this leadership role. At the same time and coordinated with the community to community strategy will be the efforts of George Williams College Aurora University’s Masters of Business Administration program to seek businesses and industries where students can see their learning in a real world situation.

Project Design Further Details

George Williams College Aurora University is a community resource that has a number of academic programs including a Master of Arts in Teaching. George Williams College is working to expand the opportunities for area teachers to engage in advanced studies. This project presents an opportunity for the

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directors of curriculum and instruction of local school districts to collaborate closely with the professors at George Williams for the benefit of area students and their teachers.

- i) This proposal will launch teacher education initiatives by creating a partnership between George Williams College and a consortium of school districts and local business and industry, building on successful professional development programs for teachers initiated by Yerkes Observatory in recent years, especially the Illinois Mathematics and Science Partnership, Astronomy Resources Connecting Schools (ARCS) funded by the Illinois State Board of Education, and the NSF funded program Hands-On Universe. Yerkes Observatory has hosted the annual meeting of Hands-On Universe Teacher Resource Agents for the past six years.
- ii) YAAYS will create/adapt/extend the experiences and materials of the program in such a way that they are accessible to the general population of students and to students with special sensory needs, implementing and inventing strategies embodied in the notion of universal design for educational materials and experiences.
- iii) Professional development will broaden our network of support for creating materials accessible to students with sensory disabilities by involving experts from the National Federation of the Blind and the WSD in Delavan.
- iv) Professional development will consist of a series of meetings or a formal class, such as a class of Advanced Science and Math Methods. Teachers will learn from the experts, but will be the leaders for activities with students with the support of educators and scientists.
- v) All program materials produced will align with national science standards and coordinate with state and school district science standards. George Williams College will coordinate this with school district curriculum specialists, who are very enthusiastic. Please see Letters of Support from local school districts.
- vi) All programs will be developed in the spirit of including special-needs populations, following universal design elements to ensure the participation of students with sensory disabilities.

Yerkes Observatory will involve scientists and a historian of astronomy, in the partnership with a strong leadership role in the development of the content, acting also as role models and mentors. Astronomers involved will bring into the program modern research endeavors. These astrophysicists will help program staff to create authentic experiences, from designing and building instruments, to using data from student-built instruments, to accessing data from modern observatories. Modern research observatories include: Sloan Digital Sky Survey (SDSS), Stratospheric Observatory for Infrared Astronomy (SOFIA), and Hubble Space Telescope. Hubble Space Telescope was named for astronomer Edwin Hubble who received his Ph.D. as a student at Yerkes Observatory. William Sheehan, historian of astronomy, will create narratives about the rich heritage of scientists who created their contributions to astrophysics through their work at Yerkes Observatory. Included in this rich heritage is Edwin Brant Frost, who himself lost his vision and continued as an active director of the observatory while blind.

Yerkes Observatory and George Williams College will create partnerships with businesses and other entities in the region to mutual benefit. Local businesses will eventually hire the graduates of the local schools, and are naturally invested in the quality of the education provided by these schools. Businesses often seek ways to contribute to education; the businesses we have contacted so far are enthusiastic about the alliances of our proposal. These alliances will be coordinated via the Williams Bay Business Association. We envisage opportunities for students that include tours of manufacturing plants with exposition of technical methods. We also envision, where appropriate, contributions of materials used in the programs by businesses. Other non-business entities in the community will also be involved. For example, we will coordinate with the Geneva Lake Environmental Agency to build programs that connect astronomy with geophysics, for example using the heat balance of the lakes to illustrate the effect of solar irradiation of the surface of a planet. We will also work with the Williams Bay Fire Department to develop programs using its infrared imager and other technologies.

Transition to High School

Local high school teachers will coordinate with us to create volunteer opportunities for high school students to assist in the use of Yerkes telescopes and program activities for young scientists. These students will function as role models and mentors for YAAYS students. Furthermore older high school students who have participated in Yerkes programs and are successful in the STEM coursework at the high school level and are recommended by their teachers will have an opportunity to work as counselors in the YAAYS summer program for students. Blind college and high school students who participated in the NASA IDEAS SEE Project at Yerkes will be paid staff to help design and test materials and activities for the young scientists with these disabilities. In a SEE Project focus group meeting in May of 2006, the HS and College students really liked this idea, and felt they have a lot to contribute to the process. Three blind or visually impaired college students will work closely with project staff for one month each summer. This provides work experience for these students as well as summer employment.

4. Recruitment

George Williams College and Yerkes Observatory have systematically organized school districts through meetings with the directors of curriculum and instruction, principals, and directors of centers for specialized learning. Administrators involved have agreed to recruit teachers and students, and assured us that this program will be well received. Commitments to participate have been received from the Geneva Lake community of schools including Williams Bay Public Schools, Walworth Joint District #1, Linn JT. 6 School District, Elkhorn Area School District, Fontana Jt. 8 School District, Lake Geneva Schools, The School District of Delavan-Darien, the WSD in Delavan, and the WCBVI in Janesville.

Furthermore, astronomy educators participating in an Illinois Mathematics and Science Partnership program, Astronomy Resources Connecting Schools, as well as the wider geographical array of Hands-On Universe teachers, are also anxious to participate and share their knowledge and skills with the teachers local to the Geneva Lake communities. Through careful design, we will engage local teachers in a teacher to teacher astrophysics education professional development component, deepening the local impact of other education programs happening at Yerkes Observatory.

Interviews and focus groups of teachers and students have resulted in our confidence that there is high interest to participate. We will plan teacher and student contact time and scheduling so that it fits realistically with teacher workload, and incorporates opportunities for teacher creativity.

George Williams College and Yerkes Observatory will design a brochure to distribute to parents and students. An informal event, "Invitation to YAAYS" will be hosted by Yerkes Observatory in mid-October 2006 to inform parents and students, and build anticipation for the program. In order to assure every effort to sustain student participation, parents will be encouraged to attend the Invitation to YAAYS, and/or have a follow up meeting with the OST teacher at their school, sign an agreement to participate which follows IRB guidelines and outlines expectations for participation, emphasizes importance of attendance for two years of programming, and clearly describes the dates, times, and locations of YAAYS programs and optional activities, as well as informs parents of the evaluation and research components.

5. Work Plan

Pre-Award August 2006

- Continue to build support from community agencies, business, and industry.
 - George Williams College, David Frost, Assistant Professor of Business
- Through funding from Lions Clubs, follow through with SEE Project 3-4 day summer program for students who are blind or visually impaired. This program originally funded by NASA IDEAS through Bernhard Beck-Winchatz at DePaul University NASA Center.
 - Yerkes Observatory Educators and SEE Project astronomers
- Through funding from the Geneva Lake Association Environmental Education Foundation (EEF), hold brainstorming and observing sessions for 5th and 7th grade students from Williams Bay to further refine focus for YAAYS activities.

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- Yerkes Observatory Educators and EEF facilitator Ted Peters

September – December 2006

- September/October. George Williams College, in cooperation with Yerkes Observatory, research and evaluation personnel, and participating school districts, creates a flier and application process for schools and teachers. School district boards and/or administrators approve the process.
- September/October. District Directors of Curriculum and Instruction and/or Principals finalize selection of OST lead teachers. Teachers sign an agreement to participate, fully informing them of the commitment, the benefits, and the program expectations, as well as the research methods and reporting responsibilities. Teachers complete university employment paperwork so that they can be paid for leading OST activities and required professional development. George Williams College organizes teachers. Yerkes Observatory provides university payroll paperwork. System worked out between GWC and Yerkes Observatory to manage teacher pay periods with documentation of effort and OST time with students. Researcher provides wording for teaching agreement of commitment consistent with IRB.
- October. Research and Evaluation: Focus groups of teachers/students for formative and baseline evaluation and research. Coordination between GWC and Researcher/Evaluator.
- Mid-October through mid-November. Invitation to YAAYS Event at Yerkes Observatory for youth and parents to inform and create a sense of excitement and anticipation. Students apply to participate, permission slips and letters of commitment signed by parents and students. Commitment by parents by November 15th.
- November - December. Inservice by National Federation of the Blind regarding blindness and vision impairments and issues for teaching and learning, as well as life skills and communication strategies. Similar inservice by experts from the WSD for understanding the teaching and learning of deaf and hard of hearing students.

2007 and 2008 School Year Student Academies

We will have academy inservice for teachers throughout these sessions. This professional development schedule will be put on the calendar by OST teacher leaders during the fall. For example, these might occur on the first Saturday of each month. Teachers will have inservice on activities for the month; all sessions will be video taped so that teachers who might have to miss a session will have the opportunity to review material and interactions during the presentations. During academies, students' activities will be led by teachers. One session a month for each of four student groups will be held at Yerkes with support of the education/astronomy staff at Yerkes. We are consciously deciding to have the teachers lead the sessions but will provide education and content support. We intend this so that the students and the teachers see the teachers as experts, and observatory and university personnel in collegial roles.

Structure locally to Williams Bay including WCBVI and WSD centers:

Students: 100 to 200 students; Teachers: 20 OST teachers

School Teams: 5-10 students/teacher

Divisions: Combinations of 25 to 50 students with 5 OST teachers

There will be four themes of exploration. The activities and explorations will be enhanced through collaborative efforts within teams and among divisions. YAAYS aims to offer students a variety of activities that are different from those in which they participate during the school day (Lauver and Little, 2005). These are proposed themes. We expect these theme ideas to be refined during the planning phases in the fall of 2006. The thoughts for these themes are as follows:

Observing the Sky (Sun, Moon, and Stars): The focus of this theme will be careful observation and journaling, discussion among peers, and simple observing equipment including binoculars, solar projecting telescopes, making, recording and tracking observations such as with solar gnomons, etc., including how to be the reporting 'eyes' for someone who cannot see while not presuming to think for them. Students will be looking with their eyes or the eyes of a seeing peer and thinking about what they see and trying to make sense of it. In a focus group with 7th grade students in Williams Bay, the students suggested that we really try to understand the Moon and its phases. They wondered "Why does the Moon sometimes have more or

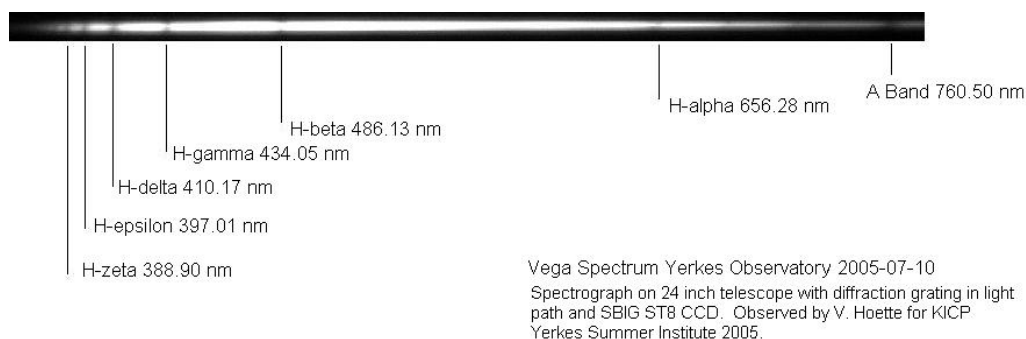
less of bright and dark shape to it? Why do you see it during the day and why is it not full when you see it in the middle of the day? Are there clouds covering it up?” From “Private Universe” (Schneps and Sadler, 1988) we know that students hold on to naïve ideas about Moon phases and other astronomical phenomena, but it is always jolting to hear a young student articulate these thoughts. In this same focus group the students decided it would be best if they kept journals to try and puzzle out what was going on rather than having the experts explain it to them. They also said they would rather first study the Moon by watching it with their eyes. In this theme we hope to invoke these kinds of questions and thinking among students; teach them to journal their ideas and thoughts; discuss as a group and pose questions and ideas for the next group to consider.

Investigate Light and EM Spectrum: (Create a spectrum, Sense Light, and Investigate Invisible Energy.) Study of the electromagnetic spectrum is important in nearly every physical science. For this theme we will begin with the amazingly successful Active Astronomy Kit published by the ASP and developed as outreach for the Infrared Astronomy missions: Spitzer and SOFIA. *Yerkes astronomers and educators have added several important components to this kit, such as a multimeter, hand-held fan as a ‘chopper’, photographs of the circuits, and masking tape tabs on the negative leads for the visually impaired students. This kit has been successful and popular with our young blind or visually impaired scientists. The multimeter allows for quantitative analysis and participation by deaf students when substituted for the kit’s speaker-amplifier.* The Geneva Lake Association Environmental Education Foundation has supported the development of activities with this kit at Yerkes for area students for the last three years. They believe that these hands-on activities that involve creating detector and emitter circuits, etc. are important experiences for our youth. The students in the SEE Project also loved using these kits. SEE Project students remarked that they had never played around with electronics, wires, batteries, and ways to sense light electronically; this “encouraged their interest in science and technology.” (SEE Project Focus Group, May 2006). This is a demonstration of the principles of Universal Design being applied to science activities (Acrey, et al., 2005). Activities with creating a spectrum and investigating it with filters have been explored with 3rd, 4th, 5th grade students in a ‘Bike the Bay’ summer school class from Williams Bay Elementary for the past two summers. These students invented many ways to mix and match filter combinations in filter holders. The students then documented their inventions for consideration by other groups of students.

Using Telescopes, Imaging, and Data Collection, Display and Analysis: Students will use the telescope resources at Yerkes Observatory and the resources of our astronomers’ research telescopes such as SDSS, SOFIA, and HST. Observing and gathering data brings in natural connections to mathematics, using instruments emphasizes technology. Focus group 7th grade students said they would like to study the Moon with telescopes but only if they had dark filters so it didn’t ‘hurt their eyes.’ They also want to do organized observing projects such as getting a set of images of Jupiter and its moons, especially Io so they can figure out its orbit radius and period, suggesting a repeat of a project done by one of their peers in 5th grade. These same students want to jump from the Solar System to a systematic study of galaxies, wondering if they could just make a collection of galaxies and write down their names and numbers. They wondered, “Could we see them all, could we memorize their names or write down their numbers?” Another group of sixth grade students while looking at the Moon with a telescope asked “Would you fall off the Moon if you were standing on it?” “I felt like when I was looking in the telescope I was right on it (Saturn or the Moon).” “I felt like a scientist when I was in there (the dome).” “I loved observing with my friends.” Observing with friends appeared in two of five student entries. The social component seems to be very important to this age group. Group experiences with time for reflections, questioning and journaling will become natural extensions of these experiences. The sixth grade classes of Williams Bay Elementary came to Yerkes for a field trip. We extended this event to include experience with image processing on an image of Moon craters. Students worked in teams to identify mystery craters by their X,Y coordinates and then pose a mystery crater for another group. They puzzled over considering which craters came first in time. Our astronomers would like to create an adjustable digital camera holder to attach to the Great Refractor so that students can easily record their own pictures to even perform data analysis. More customary to our usual observing though will be attaching CCD imaging cameras to the smaller aperture telescopes (24 inch or 8, 10 or 12 inch telescopes).

Building Instruments: Building instruments is an important aspect of STEM, emphasizing engineering. We anticipate several building projects from assembling simple refractors out of cardboard tubes and lenses to

larger 2-inch diameter refractors in a more stable tube which could be mounted on the Yerkes telescopes with cameras attached for recording astronomical data. We also anticipate making simple pinhole cameras with students, learning to use a darkroom and process their own film into prints, and eventually adding a prism or grating to their telescope to create a “spectra-gadget”. The culminating project will be spectroscopy with data taken with their own instruments. We have done this project with high school students using home-made equipment and are anxious to share it with our young astrophysicists. When this idea was presented to teachers in the ARCS program several middle school teachers were anxious to support it and requested an invitation to participate. During the SEE Project summer program in 2005, 8th grade girls who are blind imaged star spectra with the spectra-gadget on the 24-inch telescope. They explained what was happening to the light from the star as it went through the diffraction grating by relating the process to a project they had done earlier making a cardboard tube spectroscope with sighted classmates. The students who are blind made the cardboard spectroscope, and the sighted peers reported what could be seen when the gadget was pointed to various light sources. This is another example of science experiences incorporating universal design principles. Everyone is using the same equipment; everyone’s needs are met; and each contributes intellectually (Blamires, 1999; Bremmer, et al., 2002; Hehir, 2003). Spectroscopy is of special interest to YAAYS because it is quantitative, graphical, and allows for the investigation of color by students who are blind when images and graphs are made tactile, since color information in light is stretched out in the spectrum.



YAAYS Divisions will, in turn, investigate each exploration, meta-cognitively reflect on their learning, and report to the next division what they found exciting, frustrating, suggestions for enhancements so the activity easily is understood by young researchers who may be visually or hearing impaired, as well as suggestions for further exploration by the next division. In this way each of four divisions will receive design feedback from an accumulating set of four teams of teachers and students. In this manner we will give students and teachers a chance to provide formative evaluation during their learning experiences. This formative evaluation will inform the next group and influence the way they go about teaching and learning the activities. Each division will begin with a different one of the four themes. After four months all the activities will have been completed four times. Finally, each initial team of the four themes will review the reports of all the groups. They will try the activities again and synthesize the ideas and enhancement suggestions. These will be reported back to the whole group in conference style.

2007 and 2008 Summer Camps

Summer Camps will feature Spectacular Astrophysics such as building a solar spectrograph. Students will build a table top projection solar spectrograph, following a technique devised for the CARA high school program. Starting with a heliostat that is placed into a window, students will pipe sunlight through a window into a dark area of the main part of a building. The light is projected over a table top with inexpensive components of a spectrograph, including mirrors, lenses, grating, and a wall on which to display the spectrum. Students will have to discover the correct arrangement of components to be able to create a spectrum of the Sun. Summer camps will also stage an Exposition in the Grand Tent on the George Williams Campus grounds, where teams of students will present to the community the results of their endeavors. This model follows the format of several programs, but especially that of the SEE Project presentations to the Lions Club as a culminating event of their SEE Astronomy Camp at Yerkes during 2004, 2005 and upcoming 2006. Anticipating this event provides motivation to synthesize understandings, create learning products, and practice presentations. At the same time, community stakeholders see the

results of their support and contributions, as well as gain a feeling of pride in student achievement. In 2008 YAAYS Summer Camp will delve into the spectroscopy study of stars other than the sun, with similar emphasis on constructing instruments by students and analysis of images. Formative evaluation will guide the partnership to continued program success.

Student Contact for 2007 and 2008

Twice-Monthly or Weekly after school sessions at schools, community sites, and/or Yerkes Observatory

January, February, March, April, May

September, October, November, December

Adler Planetarium & Astronomy Museum Saturday Trips (four)

Yerkes Observing Nights (six)

Science Liveshow UNIVERSE (monthly but students attend once a quarter)

Summer Camp (one week per summer in the afternoons)

2009 YAAYS partnership will work cooperatively to assist in the evaluation and research reports per NSF guidelines. YAAYS partnership will also summarize dissemination activities by partners. George Williams College will lead the partnership in the goal to publish the results of our efforts for the benefit of the education and science outreach communities.

6. Research

PROGRAM EVALUATION AND RESEARCH

The Center for Elementary Mathematics and Science Education at the University of Chicago will conduct the research and evaluation portions of the Yerkes Astrophysics Academy for Young Scientists (YAAYS) project. CEMSE's science education work is directed by Dr. Jeanne Rose Century who has extensive experience evaluating science education programs including those that focus on scientist-educator partnerships and devising strategies for long-term sustainability.

The program staff have articulated outcomes specific to participating students and teachers. Achieving and sustaining improvement such as these in partnerships that involve institutions of higher education, businesses, and informal education institutions is both critically important to this project as well as difficult to achieve. Evidence to assess the degree to which these outcomes are achieved will be analyzed in the project's evaluation component. The research component will complement the evaluation by examining the factors that explain the abilities of each of the stakeholder groups to fulfill their promise to support this effort and in turn, STEM learning.

The research component will address the following two broad questions:

- 1) *What are the capacities and barriers at the University of Chicago, at Yerkes Observatory, at George Williams College Aurora University and at the collaborating business and industry partners that will advance or inhibit the sustainability of the regional hub that grows out of the YAAYS program and future work that will support science education in the region?*
- 2) *What are the roles of the scientists as partners of K-12 educators and to what extent do those roles contribute to achievement of project outcomes?*

The research will build on what is known about particular factors that are associated with institutional change and sustainability in general (Century and Levy, 2002) and in institutions of higher education specifically (Birnbaum, 1988; Wilms and Zell, 2002). Using this work as a foundation, we will gather data on aspects of the program associated with management, decision making and leadership structures, values and beliefs about public education at the organizational and individual level, organizational culture, and communication and collaboration practices. Data will be collected through focus groups, semi-structured and open-ended interviews of participating professors, business leaders and school district administrators, and document review.

Data collection will take place in each of the three years of the project. The first round of data collection will establish a baseline for understanding each of the stakeholder institutions and their perspectives on the collaboration. Additional interviews and data analysis will take place in years two and three. The research will be conducted in close collaboration with the evaluation effort. Researchers will participate in each of the evaluation project team meetings to share data and preliminary understandings. Researchers will

employ qualitative analysis techniques, such as open, axial, and selective coding (Strauss & Corbin, 1990) to analyze and synthesize the data and identify those factors which contribute to and/or inhibit future growth and success of the partnership and program.

A secondary research question relates to the role of the student populations of hearing and visually impaired students. This aspect of the YAAYS program builds from earlier work and provides a natural opportunity to conduct exploratory research on ways to best make STEM learning opportunities more available to students who are visually and hearing impaired and how to encourage their interest in science and science careers in the future. Thus, a supplementary research question is: *What strategies are proven most effective for engaging students who are visually and hearing impaired in OST experiences?*

In order to answer this question, researchers will interview leaders of the collaborating institutions that focus on visually and hearing impaired students. These interviews will take place in coordination with the interviews that focus on the development and sustainability of the partnership. Researchers also will conduct focus groups of participating visually and/or hearing impaired students in coordination with the focus groups conducted as part of the evaluation.

7. Project Evaluation

The program evaluation will be conducted in coordination with the research study described below. Program evaluation questions reflect the overall project vision of strengthening STEM student learning through OST activities developed through scientist-educator-informal science education institution collaboration. Evaluation activities are shaped by the program's articulated goals. The evaluation data collection process will be guided by benchmarks to be identified in collaboration with project leadership that identify important variables project staff have identified as critical for success. During the first two years of the project, the evaluation will be formative. Evaluators will document the projects development at the planning and implementation levels and have regular meetings with program leaders to report findings. In the third year, while still providing formative feedback to program leaders, the evaluation will also focus on providing summative findings at the end of the third project year. Evaluation questions associated with each of the first three primary stated goals are as follows:

Goal 1: Does YAAYS strengthen STEM learning in elementary and middle-school students from rural and small town settings?

- Do student participants who are directly engaged with the YAAYS program demonstrate evidence of improved science achievement in statewide, district and classroom assessments?
- Do student participants demonstrate evidence of changed attitudes about studying science and/or about pursuing science careers?

Goal 2: Does YAAYS provide effective professional development for teachers in rural and small-town settings in Wisconsin and Illinois?

- Does the professional development include those features considered critical to high quality professional development?
- Is there evidence of impact on teachers' content knowledge and pedagogical content knowledge?

Goal 3: Does YAAYS contribute to the institutionalization of the partnership so that the work of the partners to improve STEM learning for students in the region can continue into the future?

- What is the evidence that the partners are instituting changes that are consistent with establishing a foundation for future work?
- Is there evidence of increased collaboration and commitment among all YAAYS partners?

The evaluation will be conducted using both qualitative and quantitative data collection methods as follows:

Goal 1 – Students: Data collection with regard to students will be a challenge in that the student sample of 100 students will range from children in grade 3 – grade 8. Thus, data collection on student STEM knowledge and attitudes will need to be adjusted for the ages of the total student population. There is an expectation that approximately 2/3 of the students will be middle grade level. For those students, we will administer a survey (N=66). The survey will be administered prior to the beginning of students' participation and then at the end of each of the first two project years. The survey will be administered to a

comparison group of students identified in collaboration with the school district leaders. The survey will target students' science content knowledge as well as their views about science and science careers. The survey will be adapted from existing instruments including the Colorado Learning Attitudes about Science Survey (CLASS). The data from the survey will be complemented with review of student journals and logs that they will keep as part of their participation in YAAYS. Evaluators also will conduct focus groups during the student summer camps that focus on student attitudes, increased understanding of astrophysics, and their expectations for participation in the project.

OST experiences: The evaluators will observe a selected number of OST experiences and conduct focus groups with student participants focusing on their perspectives on science and careers in science as well as their views on the extent to which the experience is meeting their expectations. Evaluators will collect and/or examine student data including state science scores, course grades, focus group and questionnaire data.

Goal 2 – Teachers and Professional Development: Evaluators will conduct observations of a sample of the teachers' professional development experiences and view videotapes of additional professional development activities. Evaluators will administer questionnaires to teachers once each year that focuses on measuring their content knowledge in the YAAYS area of focus. To the extent possible, measures of content knowledge will draw from the MOSART project at the Harvard Smithsonian Center for Astrophysics. Evaluators will also conduct teacher focus-groups two times per project year targeting teacher views on their professional development experiences.

Goal 3 – Partnership and Sustainability: The evaluators will interview leaders from each of the stakeholder partners two times each project year. These interviews will be guided by a semi-structured protocol that focuses on the extent to which relationships among partners are developing and ways the program is or is not meeting program expectations.

The summative evaluation will examine the program's effectiveness and explain both what has resulted and, in coordination with the research effort, what factors have contributed to those results. Student data for the summative evaluation will be analyzed to determine whether and what correlations emerge between participation in the YAAYS program and student science learning and interest and further choices in science.

8. Key Personnel

- Yerkes Observatory: Kyle M. Cudworth, Richard G. Kron, D. A. Harper, Vivian L. Hoette
Scientists Cudworth, Kron and Harper will generate content and astrophysics projects. Educator Hoette will manage the project, coordinate with George Williams for designing professional development, and create with the scientists the basic content.
- George Williams College: Linda Olbinski and her staff will create the professional development plan and implement it; coordinate the districts and teachers, and facilitate communication with the researcher/evaluator.
- Adler Planetarium & Astronomy Museum: Karen Carney will work with her staff to create meaningful field trips and gallery experiences for the young scientists, especially planning for students who are blind or visually impaired, deaf, or hard of hearing.

Important Personnel who represent the local community and extended community of resources

- Wisconsin School for the Deaf: Connie Gartner
- Wisconsin Center for the Blind and Visually Impaired: Martin Monson
- National Federation of the Blind Jernigan Institute: Mark Riccobono
- Williams Bay Business Association: Rick Pfenning
- Geneva Lake Environmental Agency and Geneva Lake Association Environmental Education Foundation: Ted Peters
- Local School Districts: Dan Bice, Principal of Williams Bay HS and MS, Williams Bay, WI
- Collaborating ARCS Teachers: Rich Duran, Superintendent of Schools Will County, Illinois
- Lions Clubs of Wisconsin: Lion Greg Pryor

- Historian of Astronomy and Yerkes Observatory: William Sheehan
- Collaborating Scientists: Max Mutchler, Hubble Space Telescope
- Science Museum Tokyo: Kaoru KIMURA

Advisory Board Includes:

Shelley Lee, Science Education Consultant, State of Wisconsin Department of Public Instruction
Lucy Fortson, Research Astronomer, Adler Planetarium & Astronomy Museum
Noreen Grice, You Can Do Astronomy, LLC
Jennifer Leimberer, Master of Science Mathematics and Teaching
Jim Phillip, Vice Chairman, CIO Phillip's Flowers
Sue Ann Heatherly, Education Officer, National Radio Astronomy Observatory-Green Bank
Carlton Pennypacker, Hands-On Universe Co-Investigator, Lawrence Hall of Science
Debbie Stein, Parents of Blind Children, National Federation of the Blind of Illinois
Robert R. Youngquist, D.D.S, Lake Geneva

Shelley Lee, Science Education Consultant, State of Wisconsin, will bring expertise in our understanding of Wisconsin public education system and ideas for weaving our astronomy and space science in YAAYS with the school curriculum expectations as they relate to the Wisconsin standards. Lee will also be able to advise us on how to create an effective program dissemination plan engaging a critical mass of business and industry partners. Lee is passionate about astronomy and space science and has a vested interest in influencing the future of Yerkes Observatory and maximizing its potential to help realize the "New Wisconsin Promise: A Quality Education for Every Child" (WI Dept. of Public Instruction Home Page). Lucy Fortson will be able to guide us as we meld our research scientists' resources in the context of out of school time programs at Yerkes Observatory functioning as an informal science education center. Noreen Grice published the learning kit for students who are blind and visually impaired that was created in the SEE Project; Grice is also the author of several books including Touch the Universe and Touch the Sun. Leimberer is an excellent teacher of science and mathematics, has implemented Hands-On Universe with middle school students, taking advantage of the mathematics of data analysis within image processing. Leimberer will also be able to advise us regarding the art of designing collaborative learning environments for young students. Jim Phillip will advise us as a representative of the business community and how we can best integrate the businesses and industry into the effective support networks for this program. Sue Ann Heatherly is a most talented and energetic leader of education activities at a major radio astronomical observatory; Heatherly has amazing research programs for teachers; has led the effort of building a new visitor center and manages many field trip and out of school time programs for the youth of West Virginia; Hands-On Universe is an integral component of many of the programs for teachers and students at Green Bank. Pennypacker is the founder of Hands-On Universe and continues as its leading visionary; he has assembled an impressive array of extraordinary global partners as well as rich network of Teacher Resource Agents (TRAs) for HOU in the US. Debbie Stein, as the leader of parents of blind children in Illinois, will direct our efforts wisely to be ever mindful of the talent of children with disabilities and the enormous value we will add by including everyone in educational opportunities during out of school time. Robert Youngquist is an orthodontist in Lake Geneva; he is deeply motivated to guide our communities to maximize academic opportunity and resources for our youth, including the potential of the Observatory.

9. Dissemination

Our diverse group of excellent scientists and educators in university, school, state centers for students with vision or hearing impairments, quality teachers and talented students are all networked in professional organizations. We plan to present our work to these organizations which include but are not limited to: National Federation of the Blind; Astronomical Society of the Pacific, Wisconsin State Science Teachers; Illinois State Science Teachers, National Science Teachers Association; American Association of Physics Teachers, Lions Club Conventions. George Williams College is especially interested in the opportunity to produce publications resulting from YAAYS.