# COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

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PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE (If not in response to a program announcement/solicitation enter NSF 99-2)

98-45 11/16/98

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9972373

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University of Utah
1471 Federal Way
Salt Lake City, UT. 841021807

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

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(See GPG II.D.1 For Definitions) ☐ FOR-PROFIT ORGANIZATION ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS

TITLE OF PROPOSED PROJECT Science Within You:An Interdisciplinary Video Course for Non-Science Majors.

| REQUESTED AMOUNT | PROPOSED DURATION (1-60 MONTHS) | REQUESTED STARTING DATE | SHOW RELATED PREPROPOSAL NO., IF APPLICABLE |
|---|---|---|---|
| $ 496,216 | 36 months | 07/01/99 | |

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☐ NATIONAL ENVIRONMENTAL POLICY ACT (GPG II.D.10)
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# CERTIFICATION PAGE

## Certification for Principal Investigators and Co-Principal Investigators:

I certify to the best of my knowledge that:

(1) the statements herein (excluding scientific hypotheses and scientific opinions) are true and complete, and
(2) the text and graphics herein as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or individuals working under their supervision. I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if an award is made as a result of this application.

I understand that the willful provision of false information or concealing a material fact in this proposal or any other communication submitted to NSF is a criminal offense (U.S.Code, Title 18, Section 1001).

| Name (Typed) | Signature | Social Security No.* | Date |
|---|---|---|---|
| PI/PD<br>Steven E Kern | | | |
| Co-PI/PD<br>Joseph D Andrade | | | |
| Co-PI/PD | | | |
| Co-PI/PD | | | |
| Co-PI/PD | | | |

*ON FASTLANE SUBMISSIONS* SSNs are confidential and are not displayed

## Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding Federal debt status, debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 99-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuring award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflict which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

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Is the organization delinquent on any Federal debt? Yes ☐ No ☒

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

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This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

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The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

| AUTHORIZED ORGANIZATIONAL REPRESENTATIVE | SIGNATURE | DATE |
|---|---|---|
| NAME/TITLE (TYPED) | | |

| TELEPHONE NUMBER | ELECTRONIC MAIL ADDRESS | FAX NUMBER |
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## Project Summary

### Science Within You:
### *An Interdisciplinary Video Course for Non-Science Majors*

Science Within You is a 15 hour course for television broadcast that increases scientific literacy among the non-scientist student. Using the human body to captivate the individual's interest, the content explores measurement, basic physical concepts, and energy (i.e. the delivery of energy; the consumption and utilization of that energy; and sensation or the gathering of information and the utilization of that information which serves as feedback to control consumption of energy).

Science Within You is to be initially broadcast over a local broadcast station thereby serving students with special needs due to geographical location, job or family commitments, physical disabilities, or other time constraints. As a television broadcast, a wider range of viewers will access the broadcast thereby extending the learning opportunities in science to a much greater audience. A web site component provides students with written scripts, at-home laboratory experiments, and past assessment items to aid in their learning process.

*Science Within You* grew from the successful experience of the previous video course *Science Without Walls* at the University of Utah. A Lableess Lab© and Briefcase Lab© added to the video course will complement the content through experiential learning of the concepts. The video format will allow for future options such as translation to CD Rom and video segmenting for Internet.

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*Proposers may select any numbering mechanism for the proposal, however, the entire proposal must be paginated. Complete both columns only if the proposal is numbered consecutively.

## Science Within You

### Project Description

**Background and Significance**

The ongoing national discussions on undergraduate education are leading to reforms of undergraduate general or liberal education requirements. "*Shaping the Future*"[1], a report on undergraduate education issued by an advisory committee to the National Science Foundation, calls for the need to educate all students in the science, mathematics, engineering, and technology disciplines. The increasing technological basis and sophistication of our society's problems - and opportunities - is shifting a significant focus on science, math, engineering, and technology topics. It is generally agreed that all graduates need to be "literate" in science, math, and technology - what is not agreed to is a definition of "literacy."

The general problem of scientifically illiterate students was identified in the 1983 "A Nation At Risk"[2] report. This report and others lead to a variety of studies as well as major efforts by the National Science Foundation and the National Science Teachers Association. Many professional organizations also became involved, including the American Association for the Advancement of Science (AAAS) whose extensive report "Project 2061: Science for All Americans"[3] was particularly comprehensive and effective. The report argued strongly for an experienced-based literacy which emphasizes the integration, and interconnection, among all of the sciences. It was that report, issued in 1989, which greatly stimulated our interests to pursue an integrated approach to science education. It lead to the founding of the Center for Science Education & Outreach *(formerly the Center for Integrated Science Education)* at the University of Utah in 1992 which offers a range of programs focusing on the integration of science concepts and themes.

This national dialogue and experience with interest-based science education lead to our development two years ago of a unique new telecourse *Science Without Walls: Science in Your World* (SW/OW). *Science Without Walls: Science in Your World*, a forty program, twenty-hour

telecourse, was first offered in the Fall quarter of 1996 at the University of Utah. The course was developed after an intensive two-year writing and production phase by Dr. Joseph Andrade (Professor of Bioengineering, Materials Science, and Pharmaceutics) and Kristy Campbell (Producer with the Media Solutions at the University of Utah). *Science Without Walls* was never offered as an on-campus conventional course, but was designed from the very beginning to be a media intensive, television-based course. The goal was to minimize the "talking head" content associated with many conventional telecourses by making full use of the video medium to help illustrate, document, and relate the various concepts and activities in the course. The production group obtained permission to use a wide range of educational, PBS-type program segments to supplement the extensive, locally acquired video footage.

The awarding of a small Higher Education Technology Initiative grant from the State of Utah, via the Utah State Board of Regents, in July 1994, catalyzed the development and production of the course. Those funds, supplemented by University of Utah funds, and by College of Engineering funds, facilitated the completion of the course.

A unique Lableess Lab© was developed for the course to provide a means by which students could participate in experiential science activities. Laboratory exercises, experimental design, observations, and analyses are key components of the course. The video materials and laboratory are supplemented with a richly illustrated textbook, also titled Science Without Walls, which became available in preprint form a year after the initial course offering. The book and the lab are now available commercially[4] and are designed so that the course can be offered in a conventional on-campus non-television format if desired.

Funding, production, and related issues are covered in the Final Report on the course development project to the Utah State Board of Regents[5] (also available on the course website at http://www.utah.edu/cseo). The pedagogical rationale and content selection issues for the course are concisely presented in a recent commentary published in The Scientist[6].

Table 1 summarizes the quarter/semesters when the course has been offered at the University of Utah, and the enrollment in each of those offerings. It is important to note that the

University underwent a significant change from a quarter to a semester calendar effective summer 1998, which resulted in a change in course numberings, credits, and even graduation requirements.

Table 1
Enrollment Summary for Science Without Walls, University of Utah

| TERM | ENROLLMENT |
|---|---|
| Fall 1996 (Quarter) | 82 |
| Fall 1997 (Quarter) | 81 |
| Spring 1998 (Quarter) | 57 |
| Fall 1998 (Semester) | 19 |
| Spring 1998 (Semester) | 40 (expected) |

Each offering of the course to date has been given by Dr. Andrade, the writer, developer, and video host, with the help of one or two teaching assistants.

Homework and lab assignments for each of the forty individual programs are submitted on a weekly schedule. The current semester version of the course utilizes three midterms and a final examination. The first and last midterms are of the take-home, open-book variety. Sample exams can be viewed on the website[7]. The first midterm is distributed during the first week of class, at a mandatory class meeting, and students are carefully advised both orally and in the printed syllabus for the course the expectations and general time requirements. Students are urged to drop the course if they cannot commit to the estimated time requirements presented. Such an honest, open, and "enforced" drop philosophy has been very effective. The course is generally perceived as requiring a great deal of time and effort. However, a survey of actual time spent, conducted as part of the final examination each term, documents that the average time corresponds to the published time expectations for university courses, that is three hours per week, per credit hour. In our case, it is a three semester hour course, requiring roughly ten hours per week, the typical time expectation for university level undergraduate courses. For further information please view the web site.

The main objective in producing *Science Without Walls* was to provide a minimum level of scientific literacy to the general population. The goal was not to make scientists out of the audience nor to teach them to solve physics or chemistry problems, but to get them to *understand* the basic concepts and themes that underlie our natural world. This provides the background and confidence to take additional science course and to get the students involved in scientific and technological issues important in their community, state and nation.

Many of the connections in *Science Without Walls* relate science to issues surrounding the student's own physiology. The interest in these particular topics lead us to consider expanding our telecourse offerings with a class that focused on personal physiology as a means of teaching fundamental aspects of science. With our experience of *Science Without Walls*, we feel that it is a natural progression to offer a slightly more specific course centered around science from a very personal perspective.

**Project Detail**

Since much of classical and traditional science was first discovered by anatomists, physiologists, and physicians, we can teach a great deal of science and technology through the human body. We call this approach "*science by seduction*" -- find a topic such as their bodies in which students are interested, involve them in the fascination by which their bodies function, and then use their body to teach them basic science in which they might not have been interested.

The course we propose to develop, *Science Within You*, will be a course for television broadcast coupled with a web site that will provide supplementary student learning aids. In conjunction with this project, we will develop a stand-alone series of laboratory experiments that will complement the fifteen one-hour video lectures that comprise the course. These laboratory experiments will be developed separately from this grant as the cost to develop them appropriately with the video segments is beyond the scope of the CCLI-EMD program. Although the laboratory experiments will be independently informative on their own to be used without the

lecture component, they will be described in tandem in this proposal to illustrate their complementary value.

The labs will be structured to emphasize the key principles experienced and developed in each program but like the lectures developed for the telecourse, they will be stand alone components which can be used in conjunction or separate from the telecourse. While neither the lecture, lab or both components together will substitute for individual courses in physics, chemistry, and/or biology, these programs will make it possible to represent and develop many of the key concepts in the three traditional disciplines through the integrated approach we propose. At the least this project will help to develop scientifically literate citizens. At its best, it will divert more students into scientific explorations that they may have initially avoided out of fear, disinterest, or other surmountable opposition.

Table 2 notes the general structure and organization of the course and its 15 one-hour weekly programs. The material is organized in five general sections: the introductory section deals specifically with measurement and basic physical concepts; the second section focuses on energy, the third section focuses on the delivery of energy; the fourth section covers the consumption and utilization of that energy; and the final part focuses on sensation (the gathering of information and the utilization of that information which serves as feedback to control consumption of energy). The title of each one-hour lecture is intentionally made interesting, and is descriptive of that particular topic.

On the far right of Table 2 the various laboratory experiments and measurements are indicated. The simple laboratory experiments in *Science Without Walls* proved to be very helpful for the understanding of the lecture materials. *Science Within You* will continue to use this concept as a supplement to the lectures but will also expand this idea to include directed, mentored lab sessions that would be held at regional learning centers. The combination of hands-on Lableess Labs© and mentored Briefcase Labs© will allow for self-directed and mentor-directed experiential learning to supplement the material in the videos. The real world can never be fully appreciated or experienced from a television or computer screen alone – virtual realities are

virtual, not real. We feel strongly that this complementary approach, focusing on personal physiology, will provide a means to involve a much larger segment of the student population in the enhancement of their scientific backgrounds.

There are two laboratory designations. H refers to the home-based or personal laboratory which we call the Lableess Lab©. With these simple labs, the students perform measurements in their home or apartment. The more extensive, comprehensive lab, is the Briefcase Lab©, noted as B in Table 2. Under each weekly lecture topic is included brief notes on how the topic content connects to key topics in more traditionally organized physics, chemistry, and/or biology basic science courses.

Table 2 ***Science Within You***

| Week | Section Structure | Video | Companion Lab (H = home B= briefcase) |
|---|---|---|---|
| 1 | Introductory | ***You're Abnormal*** Measures of normality. Personal Physiology. Measurement in physiology. | Temperature measurement (H) |
| 2 | | ***You're Imperfect*** Symmetry, proportion, ratios, perspective, ancient physiologists and anatomists- especially Leonardo. | Morphometry (H) |
| 3 | | ***Lies and Electrons*** Bio-electricity, twitching frogs, sweat, skin, and lie detectors. | Body impedance / fat (B) |
| 4 | Energy | ***More Power to you*** Food, fuel, aerobics, and anaerobics. Why bladders? Why the waste! | Urinalysis (H) |
| 5 | | ***Hiking, Diving, Running*** Why oxygen? Why altitude or pressure? Acidosis-alkalosis- and Maalox. pH and $CO_2$. | $Pco_2$ (H) |
| 6 | | ***Can't even break even*** Energy, inefficiency, entropy. Fatness, thinness, and biochemistry. | Basal Metabolism (B) |

Table 2- continued *Science Within You*

| Week | Section Structure | Video | Companion Lab (H = home B= briefcase) |
|---|---|---|---|
| 7 | Delivery | ***Hot stuff – warm blood*** Cycles and rhythms. Hot blood v. cold blood; hypothermia. | Blood pressure (H) |
| 8 | | ***Body electric*** Let's start the heart! EMG, EKG, EEG, and bio-feed back | Heart rate (H) |
| 9 | | ***Body magnetic*** Electricity is magnetism – and vice versa. Birds and bacteria do it – do you? Magnetic "Vision". Medical imaging. | Electrocardiography (B) |
| 10 | Consumption | ***Gravity wins*** What goes up...the oppressive atmosphere. Mass-weight. Big folks and little folks. | Muscle fatigue (H) |
| 11 | | ***Newton rules biology*** Those laws of motion! Sneakers, high jumps, baseballs, and skis. | Friction forces (H) |
| 12 | | ***Where did the energy go*** Crashing, deceleration and fracture; Tendons, ligaments, and joints. Controlling motion. | Chicken Bone Mechanics (B) |
| 13 | Sensation | ***Senses and sensibility*** Pressure, frequency, intensity, sound – voice, music, taste, smell. A dog's view of you! | Tactile senses (H) |
| 14 | | ***Photon world*** Eyes and vision. Is it real? Perception and "reality". How many photons – night vision, me? Color, depth, and 3-D. | Taste (H) |
| 15 | | ***Summary*** Wide ranges of normalcy, pitfalls of measurement, use for understanding of medical science,where to next?? | Vision and Auditory experiments (B) |

The concepts presented within each of the five sections would have continuity and reinforcement of the central themes of the section. As an example, the introductory section will provide the students with a framework for understanding how to approach material in the rest of the class while learning basic scientific concepts which will coincidentally help them to think about scientific issues in general. For instance, the first lecture topic deals with abnormality. Before

understanding abnormality, one must comprehend normality and to do that, we must fundamentally know how to measure or compare things. These introductory lectures will first deal with different measurement systems ( ordinal and cardinal ) and then move into understanding of the importance of international standards for units of measurement. We will then move to discuss variability and how the concept of normal usually encompasses a range rather than a fixed magnitude of a parameter of interest. This can easily be demonstrated by measuring some magnitude for a group to which the student belongs ( i.e. weight and height of all your peers).

From this we will build on the idea of a distribution of values that comprise normal, the role of a "bell-shaped" curve in describing normality and then evolve the numerical descriptive terms which parameterize our definition of normal ( i.e. mean, standard deviation, standard error). This naturally leads to a discussion of probability and the concept that normal is defined in terms of the probability that a given measurement of a person is expected to occur or is not very likely as a result of chance. Finally we can also address the issues surrounding variability in measurement. These include measurement errors, dirunal or seasonal variations of parameters, and variations based on where the measurement is taken. Again these become problems for easy self-analysis through the, for instance, recording of temperature changes that occur over the course of a day for a student. Using simple stick-on disposable skin thermometers from the Lableess Lab© kits, students will be able to effortlessly study these issues on their own in limitless detail.

In the next section, we will use the concepts of measurement and normality to discuss issues surrounding symmetry, balance and imperfection. Symmetry and proportion lead to understanding of ratios and visual perspective which are important aspects for estimation, approximation methods, and concepts of scale. These issues lead to discussions of role shape, spatial patterns, and temporal synchrony in natural and unnatural systems. Finally, these are related back to the prevalence, or not, of symmetry in physical systems. This will be supported by the lab on morphometry. Though humans appear at first glance to be symmetric in structure,

there are subtle differences that distinguish left from right which can be measured and explored from the student's own body. This can lead to further discussions of anatomical asymmetries for physiologic aspects that can't be measured. Discussions regarding why symmetry would be good and why it would not are natural extensions of these concepts and can lead into understanding of energy utilization and efficiency in natural systems.

The section then finishes with the introduction of bioelectric phenomenon to set the stage for the following section on Energy. Using the concepts of measurement, symmetry, balance and proportion, we will begin to explore the ideas of how electrical charges move through our inhomogeneous asymmetric bodies. With highlights given to conscious functions such as movement and thinking and unconscious functions such as heartbeats, blood flow, and respiration, we will explore the role of ionic flows through the body which enable us to do all that we do. Making parallels to other physical systems, we will discuss issues of impedance which alter or direct these flows, polarity which drives the flow of energy against impedance, and homeostasis which brings systems towards equilibrium. Further this allows us to investigate imperfections and dynamic properties of systems that are brought seemingly to a homeostatic point but then begin to oscillate back from whence they came. This yin/yang cyclic flow of energy offers abundant examples for understanding many basic natural physical phenomenon.

The lab for this video segment will eventually be part of our Briefcase Labs©. These are so named because we will develop travelling ready-to-use experiments that a trained mentor, likely a local teacher, scientist, engineer, or curious member of a local community, will conduct at different sites throughout the broadcast region of the telecourse program. These Briefcase Labs© will use materials and equipment that are not normally found at home and allow for a deeper level of experimentation and hopefully understanding to occur beyond the ideas presented in the Lableess Labs©. The lab on body impedance and fat will use some of the data from the previous lableess lab on morphometry and temperature to explore diffences in skin impedance. We will investigate how impedance can change with differences in body fat, which effectively produces a level of isulation, and the temperature of the area being measured. We will then change the

system either though exercise or externally applied energy to look at the impact on the measured property of interest. This will lead to discussions of changes in inhomogenous tissue properties due to circulation and the presence of more ions to produce a greater current flow.

Thoughout the lecture sections, we continually bring fundamental science concepts to the students for understanding through exploration with themselves. Tables 3 and 4 show how the lecture and laboratory topics of the individual programs connect to the basic concepts and themes developed in the "*Project 2061*" report and used in our *Science Without Walls* telecourse.

Table 3 **Summary Matrix of Program/Concept/Discipline Relation Basic Concepts and Themes.**

| Week | Basic Sciences | | | | SYSTEM | MODEL | SCALE | CONSTANCY | CHANGE | MATTER | ENERGY | DISORDER | LIFE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Math | Physics | Chem | Biology | | | | | | | | | |
| 1 | | | | | | | X | X | x | | | | |
| 2 | | | | | x | x | X | | | | | | x |
| 3 | | | | | x | x | | | | X | x | | x |
| 4 | | | | | x | x | | | | X | x | x | |
| 5 | | | | | | | | | x | X | x | x | |
| 6 | | | | | | | | X | x | | x | x | |
| 7 | | | | | | | | X | x | | x | | |
| 8 | | | | | x | x | | | x | | x | | x |
| 9 | | | | | | x | | | x | | | | x |
| 10 | | | | | x | | X | | x | X | x | | |
| 11 | | | | | | | X | | x | X | x | | x |
| 12 | | | | | x | | X | | x | X | x | x | |
| 13 | | | | | x | | | | x | | x | x | x |
| 14 | | | | | | | | X | x | | x | | |
| 15 | | | | | x | x | X | X | x | X | x | x | x |

Table 4 *Science Within You* Labs and Basic Science Principles

| Week | Lab/Topic | Basic Science Topics and Principles |
|---|---|---|
| 1 | Temperature | Heat energy |
| 2 | Morphology | Size relationships and patterns |
| 3 | Impedance | Electricity |
| 4 | Urine | Molecular characteristics |
| 5 | $pCO_2$ | Gases |
| 6 | Basal Metabolism | Free energy and conservation of energy |
| 7 | Blood Pressure | Force and pressure |
| 8 | Heart Rate | Waves and cycles |
| 9 | ECG | Electricity & magnetism |
| 10 | Muscle Fatigue | Chemical energy and momentum |
| 11 | Friction Forces | Newton's Laws |
| 12 | Chicken Bone Mechanics | Structure |
| 13 | Tactile | Pressure and nervous system |
| 14 | Taste & Smell | Chemicals vapors |
| 15 | Vision & Auditory | Waves and color perception |

**Review Teams**

Each content section will be outlined by the team of Dr. Andrade and Dr. Kern with the input of Ms. McDonald, a science educator on staff at the Center for Science Education and Outreach. For each content section, teams of colleagues selected from the University of Utah and other institutions will be asked to review the scripts for content accuracy and suggestions for graphical material.

*Science Within You* combines the resources, talents, and interests of components of a modern research university which rarely cooperate and integrate. We will bring together resources from the Graduate School of Education; the Departments of Biology, Chemistry, Physics, and Mathematics; College of Medicine; the Colleges of Pharmacy, Nursing, and related health sciences; and the Department of Bioengineering, which is very experienced in the development and application, and the limitations, of modern science technologies.

The traditional basic science fields will be represented by a group of faculty with very strong interests, activities, and credentials in undergraduate science education and with considerable experience in the Center for Science Education and Outreach. These include Dr. Sherry Southerland, Professor of Science Education; Dr. Paula Wilson, Professor of Geology and Geophysics, Dr. Carleton Detar, Professor of Physics; Dr. Tom Richmond, Professor of Chemistry; Dr. Don Tucker, Professor of Mathematics; and Dr. Dennis Bramble, Professor of Biology. These individuals will review the scripts for *Science Within You* for accuracy and current information.

**Production**

*Science Without Walls* will be produced locally using the telecommunication resources of KULC Channel 9, a University of Utah affiliated educational television station in Salt Lake City. KULC reaches over 80% of the state's geographic region and overlaps into four neighboring states. The beauty and potential of our statewide telecommunications technologies is that practically all segments of the population and all geographic regions can be readily served because the television is nearly ubiquitous in our society.

Dr. Paula Crnkovich Millington, Director of Media Solutions, will lead the production team for KULC and *Science Without Walls*. For this project, they will assemble the video segments to be identified for 60-90% of the script and establish a shooting and acquisition list and schedule. Working with our existing, extensive video library – including the 20 hours of *Science Without Walls* – they will select, acquire, and implement the needed broadcast quality video. Up to 25% of the video will be shot in local hospitals, clinics, and biology/physiology/bioengineering labs by the Media Solutions team in close cooperation with the project technical and education staff. The script will then be revised to reflect the available video, and finally, the studio shooting of the host-narrator will be obtained. The shows will be produced in sequence, so later shows can refer to earlier programs, thereby helping to integrate and tie together all the programs. The video and audio tracts can be readily digitized and fed to any appropriate optical medium,

particularly CD-ROM. We will make the tapes available so that end users can deploy the contents as they see fit for not-for-profit use.

In conjunction with Media Solutions and KULC Channel 9, we have determined a preliminary schedule for producing and offering these courses:

7/99: Funds available. Begin scripts for Programs 1 -15. Evaluation plan begins. Review teams contacted. Scripts sent to review teams as available.

7/00: Scripts finalized. Evaluation results factored into final scripts. Field shooting detailed and begun for Programs 1 - 15.

12/00: Studio shooting beings for Programs 1 - 15. Test broadcasts made and evaluated.

5/01: Begin final production of video segments by Media Solutions and KULC.

9/01: Final production complete. Web site and assessments begin. Preparations for broadcast in Spring semester 2002. Review dissemination of course with Media Solutions.

1/02: Course broadcast. Web site completed. Reports and analysis completed.

7/02: End of video production for *Science Within You.*

**Evaluation Plan**

The importance of a strong, formative evaluation of instructional video productions and printed instructions is supported by numerous research findings. Revisions of the video and printed instructional productions have yielded higher student performance than unrevised versions (Baker and Alkin, 1973). It has also been shown that intuitively revised programs were less effective in improving student performance than versions revised using formative evaluation data (Rosen,1968). Feedback from prospective audience and consumers (students and teachers) has yielded similar results. In Fleming's (1963) study, product revisions resulting from student data were superior to film revisions based on advice from subject matter experts. There has never been any research evidence that data driven revisions of instructional material produce lower student performance (Flagg, 1990). This body of research evidence is the basis for the extensive

formative and summative evaluation plan proposed to field test *Science Within You* in order to assure the highest quality and most effective educational program possible.

**Formative Evaluation: Production (Alpha 1 & 2 Test Stages)**

**Alpha 1:** During the prototype stage of production, early versions of the program materials will be used to obtain feedback from students. Among the materials to be field tested are storyboards, scripts, and program outlines. This early test of the video and instructional materials will reveal any possible larger, global problems with the program. The evaluation team will measure the adequacy, effectiveness, and appeal of the program design. We will examine the appropriateness of language level, the ease or difficulty in managing the pilot program, the effectiveness of the program's instructional strategies, and the appropriateness of the content for the target audience. The evaluation team will identify the successful aspects of the program's design. At this stage, the development team can incorporate the formative feedback into program modification as needed.

**Alpha 2:** The later test versions will have most of the program components in place. At the Alpha 2 stage, the evaluation will shift to look at the program's appeal, comprehension, persuasiveness, and user friendliness. Multiple methods of measurement will be used, such as observations of the target groups, appeal rating sheets, questionnaires, as well as interviews with individuals and small focus groups. The value and consequence of obtaining immediate feedback at this stage of the production process is that it can influence program modification before the implementation version is produced, and may also influence the format of other videos under production but not yet tested. At this juncture the evaluation team will pilot and refine evaluation instruments to use during the implementation phase of production. Refinement of the instruments will assist the evaluation team in collecting data necessary to determine the impact of the program in later field tests. The data we propose to collect during the formative stages -- such as some mini-case studies and student interviews -- will provide not only complementary evidence to the statistically significant data collected through questionnaires and unit tests, but qualitative evidence which conveys the power of the video medium.

**Formative and Summative Evaluation: Implementation (Beta Test Stage):**

In this final stage of production the evaluation effort is focused on the target audience and users of the materials in natural settings. This test will be conducted in a number of classrooms which provide the team information about normal use in typical classroom settings with diverse student populations. The pilot test sites will be representative of schools found in rural, suburban, and urban communities. The data collected during the beta test stage may be used to make minor adjustments in the program, identify problems in using the program, help inform the development team of needed documentation and training support, and provide information which is useful in future program design and production decisions.

Methods employed by the evaluation team at this stage include classroom observations, interviews, questionnaires, and quantitative measures which will "make the case" for about the effectiveness of the program in meeting its goals.

**Staffing and Reporting**

Dr. Steve Schneider, Director of Mathematics and Science at WestEd will work with the *Science Within You* staff and direct the evaluation. Dr. Schneider will review all questionnaires, assessments, interview protocol, and other data collection instruments developed by project staff and assist in the analysis of the project data. The development team and Dr. Schneider will communicate regularly utilizing email, video and teleconferences, as well as selected advisory and/or management meetings to allow for ongoing formative feedback.

**Project Personnel**

The *Science Within You* team has a strong track record based on the *Science Without Walls* project and now comes with more experienced leadership. Though actively involved with individual research programs, the team has a strong commitment to undergraduate education and will put the necessary effort forward to accomplish this program. This is aided by the addition of an undergraduate curriculum in Bioengineering scheduled to commence at the University of Utah

in the Fall of 1999. With the development of this new curriculum, priorities and opportunities will change so that emphasis in teaching and new course development will increase. This will allow the team members to shift some of their priorities towards efforts like *Science Within You.*

**Dr. Steven Kern, PI**, is Assistant Professor of Anesthesiology and Bioengineering. He has worked with the Co-PI who has served as a mentor over the past six years on projects related to science education and understanding the impact of health care technology on patient care costs and outcomes. Dr. Kern is teaching a graduate class on cost reducing health care technology, gives regular lectures on technology issues to medical students often are not specifically trained in technology areas, and also makes science presentations in the Salt Lake Public School System. He is involved in the development of the new undergraduate curriculum in bioengineering at the University of Utah and is highly interested in providing high quality science courses for undergraduate, non-science majors as well.

**Dr. Joseph D. Andrade, Co-PI**, Project Director for *Science Without Walls* and Professor of Bioengineering, will mentor the program development effort. Dr. Andrade's *Science Without Walls* is a video series designed for television broadcast that integrates the science disciplines while presenting fundamental scientific concepts. His experience with this series and his experience in doing programs to enhance scientific literacy in the public education will be drawn upon to produce *Science Within You.*

**Dr. Steven Schneider, Evaluator,** has extensive experience in the area of science, math, and technology education and is the Director of Mathematics and Science at WestEd. He has directed evaluations of the following projects: PRISM (a K-3 teacher enhancement program); SCAMPI (a high school physics teacher enhancement program); the California Scope, Sequence and Coordination (SS&C) project funded by National Science Foundation (NSF); IMMEX (computer-based problem solving software development and implementation), NSF supported Science 2000 curriculum development project, to name a few. He was a team leader for NSF's National State Systemic Initiatives evaluation to improve science and mathematics in 26 states, and was the research and evaluation coordinator of a five year $2.5 million dollar State of

California funded model technology school project. He has extensive experience in managing both qualitative and quantitative evaluations, developing and field testing the research instruments, organizing and leading field research teams, management and analysis of the data, and writing interim and final reports. Dr. Schneider is also well versed in the management of qualitative data collections and has developed relational data bases to facilitate qualitative data reduction, analysis, and case writing.

**Dr. Paula Crnkovich Millington , Director of Media Solutions**, has 15 years of experience in planning, developing, and evaluating technology-mediated instruction for K-12, higher education, and corporate training audiences. She recently provided planning and production support for Interactive Mathematics produced by Academic Systems Corporation and used on more than 300 US campuses. Dr. Millington will coordinate all video production aspects of *Science Within You*, including state-of-the-art resources and an award-winning production team.

**Dissemination**

Within the scope of the three years requested in this proposal, *Science Wtihin You* will be produced and offered in the spring semester of 2002. The broadcast will be aired on the local public broadcasting station over 80% of the state of Utah and in overlapping regions of Idaho, Wyoming, Colorado, and Nevada. As in *Science Without Walls*, it is anticipated that a textbook, based on the scripts, will be developed to complement the course.

At the end of production, the Center for Science Education and Outreach staff will work with Media Solutions to promote *Science Within You* to regional and national markets. A report on the course will be compiled and be made available to others who are promoting telecommunications to reach student populations. We plan to disseminate information about the program through the media resources of the Center for Integrated Science Education's web site.

Future options coupled with additional funding will be to make the course available on CD ROM and as video segments on the web site. In the creation of CD-ROM based materials for this

course, we will work to collaborate with the *Slice of Life* project at the University of Utah. *Slice of Life* produces and distributes a number of videodiscs, CD-ROMs and interactive computer software programs.

**Summary**

The project is innovative in its emphases on an interdisciplinary approach to education and to connecting and relating the topics to real world, personal problems. The project is designed from the very beginning on several key principles:

1. The presentations must be interesting, lively, and entertaining with as much high quality video material as possible.
2. The content must be personally relevant, dealing with topics and issues of nearly every day relevance and importance.
3. The material must not be overly simplified, spoon fed, nor superficial, but rather treat the viewers and participants as responsible, caring adults with personal, family, and community interests.
4. Video and electronic information technologies are important but constitute only a part of the overall delivery mechanism. Printed material and laboratory, experiential, hands-on activities will serve as important supplements.

Through the combined impact of an interesting media format for presentation of didactic material, a home based lab that induces self-experimentation and discovery, and a mentored lab session that provides access to interesting technology, we will provide science in a way that non-science majors find inviting, accessible, and coherent because it operates from a domain in which they are intimately familiar, *themselves!* This not only provides a stimulating platform from which to learn science concepts, but may create a better understanding of personal physiology which increases their personal health and physical science literacy simultaneously.

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***Education***

Ph. D., Design and Evaluation of Educational Programs, Stanford University, 1989.
Specialization in Science Education, Cognition and Organization Analysis, Policy Implementation, and Teacher Education.

California Life Teaching Credential, Biological Sciences, California State University, San Jose. Science Intern Teaching Program 1973.

A. B., Biological Science, University of California, Berkeley, 1972.

***Teaching Experience***

1985 - 1988 Stanford University, Stanford Teacher Education Program. Supervisor of science, mathematics, and computer programming student teachers. Instructor Science methods course.

1983 - 1985 University of California, Santa Cruz. Instructor in Science Education, General Curriculum and Methods.

1978 - 1983 Santa Cruz High School. Physics, Oceanography, General Science (including Health, Drugs, and Family Life education), and Science Department chairman.

1973 - 1978 Piedmont Hills High School, San Jose, CA. Biology and Life Science.

***Selected Publications***

Arbuckle, S. H. & Schneider, S. A., (1993) Science Education for All. (Paper published and presented at the Third International Science Education Conference, Jerusalem, Israel)

Porter, A., Kirst, M., Schneider, S. A. et al. (1993). "Reform Up Close: What is being taught in science and math classrooms." Technical Report for the National Science Foundation.

Schneider, S. A., (1992). "The Intended Curriculum: The Teacher's and District's Perspective of What Gets Taught." (Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.)

Schneider, S. A., (1989). "Uncovering the Preconceptions of Preservice Science Teachers Using Script Analysis" (Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.)

Schneider, S. A., (1989). "Enactive and Vicarious Learning in Preservice Science Teachers: in the context of Macroteaching" (Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.)