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**Final Report
for
NASA Grant NAGW-3984 "Nebraska Earth Science Education Network: Enhancing the NASA,
University, and Pre-College Science Teacher Connection with Electronic Communication.**

**David C. Gosselin, Director
Nebraska Earth Science Education Network**

This is the final report for NASA Grant NAGW-3984 "Nebraska Earth Science Education Network: Enhancing the NASA, University, and Pre-College Science Teacher Connection with Electronic Communication. The primary goals of this project were to: 1. Promote and enhance K-12 earth science education; and enhance the access to and exchange of information through the use of digital networks in K-12 institutions. We have achieved these two goals. Through the efforts of many individuals at the University of Nebraska-Lincoln (UNL), NESEN has become a viable and beneficial interdisciplinary outreach program for K-12 educators in Nebraska. Over the last three years, the NASA grant has provided personnel and equipment to maintain, expand and develop NESEN into a program that is recognized by its membership as a valuable source of information and expertise in earth systems science. Because NASA funding provided a framework upon which to build, other external sources of funding have become available to support NESEN programs. Table 1 summarizes current NESEN programs.

Table 1. Current Projects and Activities

- **Process-oriented Environmental Change Education: A Model for Connecting Research to the Classroom**, Co-PI, Steve Meyer, UNL School of Natural Resource Sciences, National Institute of Global and Environmental Change (NIGEC), U.S. Department of Energy, \$65K.
- **Enhancing K-12 Drought-Related Educational Activities and Materials**, National Drought Mitigation Center, \$12K.
- **Earth Systems Science for Elementary/Middle School Pre-service Teachers**, Howard Hughes Medical Institute Grant, UNL Department of Biological Sciences, \$6,100 + Teacher Assistants.
- **Students and Teachers Exchanging Data, Information and Ideas**, Partial funding from both NIGEC and NASA.
- **NESEN Two-Day Summer Teacher Workshops**, Workshop fees, Conservation and Survey Division, and NASA.
- **NESEN Website Development and Maintenance** (<http://nesen.unl.edu/nesen.html>), Silicon Graphics Workstation provided through NASA grant.

In addition, NESEN also distributes a periodic resources and information guide (copies enclosed), a quarterly newsletter, and on-line educational activities, as well as maintaining a video and educational resources lending library. Our website (<http://nesen.unl.edu>) features a variety of educational resources, which include numerous NASA sites in the "Evaluated Links" part of the website. Other accomplishments and products related to NESEN include:

- An increase in NESEN membership from around 140 in May 1994 to over 400 in 1997.
- Participation in NESEN-sponsored activities at the Nebraska Association of Teachers of Science Annual meeting has increased at least three fold and was over 120 in 1996.
- NESEN has been featured at national and international meetings. Publications include:
 - Gosselin, D.C.**, 1994. Nebraska Earth Science Education Network, (poster) Coalition for Earth Science Meeting, Reston, Virginia, March 4-6.
 - Gosselin, D.C.**, 1995. Nebraska Net Links Teachers, Geotimes, 4, 5.
 - Gosselin, D.C.**, D.R. Mohlman, and M.P. Carlson. 1995. Nebraska Earth Science Education Network (NESEN): A State Geological Survey Enhancing the University-Teacher Connection, (poster) Geological Society of America Annual Meeting Abstracts with Programs, A-414.
 - Gosselin, D.C.**, 1995. Nebraska Earth Science Education Network, (abstract) Coalition for Earth Science Meeting, Washington, D.C., June 2-4.

Gosselin, D.C., J.L. Wright, A.M. Matherne, D.R. Mohlman, and F.V. Belohlavy. 1995. The Nebraska Earth Science Education Network Initiative. *Journal Geological Education* 43, 26-29.

Gosselin, D.C., D.R. Mohlman, M.A. Mesarch, and S.J. Meyers. 1996. Nebraska Earth Science Education Network STEDII-ly Enhancing the University -Teacher Connection. *Science Education International* 7, 5-8.

Mohlman, D.R., M.A. Mesarch, and **D.C. Gosselin**. 1997. The Nebraska Earth Science Education Network (NESEN): Connecting University Resources and K-12 Earth Science Educators. (abstract) Nebraska Academy of Sciences, Annual Meeting, April.

Gosselin, D.C., D.R. Mohlman, S.J. Meyer, M.A. Mesarch, and B.P. Lang. 1997. Nebraska Earth Science Education Network (NESEN): Connecting University Resources and Earth Science Educators, (abstract) GeoSciEd II, Second International Conference on Geoscience Education, University of Hawaii-Hilo.

A specific objective of this project was to demonstrate that electronic communication combined with adequate educational support can make a difference in education. To accomplish this specific objective, we provided, to varying degrees, support for electronic connectivity (56K lines, routers, etc.), computers, and other logistical support for eight pilot site schools across Nebraska. To provide focus for activities at the pilot schools and other interested sites, NESEN instigated the Students and Teachers Exchanging Data Information and Ideas (STEDII) project involving K-12 teachers, students, preservice teachers from UNL Teachers College, and faculty from the UNL Department of Agricultural Meteorology. Nearly 50 schools are now involved in the project, which has students actively collecting and using weather data, as well as related websites. We also develop, distribute and support educational materials that are in a compilation of *Weather, Climate and Related Educational Activities*, which are both available in hard copy and from our website. The STEDII project has been featured in at least five newspaper articles around the state, most of which acknowledge NASA funding.

To evaluate the electronic communication project, teachers from the eight pilot sites were asked to address the following 10 questions. A summary of their responses is provided below.

1. Did this project provide you with opportunities that would have not been available to you otherwise? This project provided opportunities for both students and teachers to utilize and apply internet resources in the classroom, especially email. As noted in the responses to several questions below, this project provided a "jump start" to the use of electronic networks at all sites.

2. In terms of the implementation of electronic media in the classroom and connecting to the network, what barriers did you experience while trying to implement the technology into your classroom activities? What are the greatest barriers to the implementation of networking technologies in the classroom? The four themes among the responses to this question were: 1. inadequate technical support was available within the school to assist in trouble-shooting, developing appropriate local area networks, and computer installation; 2. shortage of computers to allow individual student access to computers and the worldwide web; 3. where computers are available there are inadequate resources allocated to keep pace with the increasing demands for upgrades of current systems in terms of additional RAM memory and faster processors so that schools can take advantage of World Wide Web resources. Educational website developers need to keep in mind that there are limitations to the technology available in K-12 institutions; and 4. technology and access may be available, but the lack of technical training among teachers or the time to obtain training makes it difficult for them to implement and take advantage of technology in the classroom.

3. Do you do anything differently in your classroom, curriculum or daily activities as a result of this project? The common theme among the responses to this question was that there appeared to be an improvement in the quality of research and class projects because of access to resources on the World Wide Web. In addition, it provided opportunities to communicate with students, teachers and scientists with whom they would of have not been able to otherwise.

4. Have there been any changes in your school, beyond your classroom, in terms of the use of technology? What role did this project have in these changes? All eight sites noted that this project played a significant role in the use of technology within the school. The financial and logistical support provided the framework so that schoolwide utilization of internet and World Wide Web technology moved along more quickly. This project put schools a year or more ahead of where they would have been if they would not have been involved in this project. Because of the framework provided, four schools noted the implementation of school-wide systems of grade

reporting, transcripts, student attendance and computer networking. In the case of Pius X, a parochial high school, this project served to leverage additional financial resources from several local businesses that have provided computers, access to T1 lines and technical support to connect all classrooms via a local area network. A high school in a rural area at North Bend, Nebraska, was open several nights a week to provide internet access to the community.

5. Did this project have an impact on your students? At all sites, there was a positive impact on students, but the type of impact varied from site to site. Whether it was elementary or secondary school, all sites noted increased enthusiasm from their students as they used the internet to support their research or science fair projects. The quality of the research projects also improved. One teacher noted that the critical thinking skills of their students improved as internet use increased because they began to evaluate and question the quality of information from various websites.

6. How did your students respond to the access to the World Wide Web? What barriers did your students experience to accessing the WWW? At all sites, the World Wide Web was well received. The primary barriers to accessing the WWW were access to computers and the large volume of information that is available. Although potentially useful the large volume of information available makes it difficult to efficiently access information. This is especially true if the computer being used does not have sufficient RAM and computing speed to download information, especially information that is primarily image or graphically based. Another limitation to student access was parental concern about the types of information available on the WWW, which resulted in a teacher always having to be present to monitor the activities of the students.

7. Have you or your students found the NESEN WWW site a useful tool? The NESEN website was found to be a very useful tool at all sites for both students and teachers. Specifically it provided an access to point or "spring board" to the large amount of data and information available on earth science on the web. In addition, the associated STEDII website provided students with the experience of inputting and downloading data from a data storage facility hosted by the High Plains Climate Center. Lesson plans and activities available from both the NESEN and STEDII sites were also used in the classrooms.

8. Was the investment that NASA made in this project worthwhile from a cost effectiveness standpoint (i.e., costs versus educational benefits)? All sites agreed that this project benefitted their school as well as the entire school system. This project "jumped started" and accelerated the use of technology in the various school systems. This initial investment made by NASA assisted the schools in demonstrating the useful applications of computer networking and electronic communication in the classroom. As a result, internal reallocation of funds to expand internal computer networks resulted. In addition, in several cases the benefits have expanded beyond the teachers and the students to administrators and the community.

9. What suggestions would you make to administrators regarding the implementation of technology in the classroom in terms of how to do it most effectively? Implementing the use of technology in the classroom is not without obstacles. Success is strongly a function of cooperation between teachers, administrators and students. Teachers need to be provided the opportunity for training and on-going technical support. This provides them with an opportunity to build their confidence in the use of the technology. Equipment is of no use if teachers cannot operate it. One of the most valuable aspects of this project was the technical support provided by NESEN, which otherwise was initially unavailable at the majority of sites. NESEN staff assisted in establishing network connections, configuring computers and providing on-going technical support and trouble shooting of individual computers. Administrators and the community need to recognize that change does not happen in one or two days. Changes takes a persistent and consistent effort that is guided by establishing priorities and developing 2 to 3 year plans to implement changes. Purchasing equipment that is the least expensive is not necessarily the most cost effective, especially when hardware and software upgrades will need to occur because of the rate at which technology changes. Technology is a journey and not a destination and it must be recognized that upgrading is a part of the process of implementing technology in the classroom.

10. Please provide a list of what technological, logistical support as well as equipment that we provided to your classroom or school. Support varied at the various locations depending on resources available. Six sites were provided with 56K lines for 2 to 3 years depending on the site, router, IBM or Macintosh computer, and printer. Two other sites were provided with computers. In addition, for the STEDII project, curriculum guide and weather instruments were provided to the teachers. A teacher-student workshop at UNL helped to introduce participants to the Internet. Technical assistance was provided to various sites per request.

In summary, the goals and specific objectives for this project were achieved.

Publications Related

to

**NASA Grant NAGW-3984 “Nebraska Earth Science
Education Network: Enhancing the NASA, University, and
Pre-College Science Teacher Connection with Electronic
Communication.**

NEWS NOTES

Nebraska net links teachers

Developing practical solutions for environmental and natural-resources problems requires a citizenry that is earth-science literate. Therefore, substantial and sustainable changes must occur in the educational system to improve communication among earth scientists, science educators, parents, and students. The Nebraska Earth Science Education Network (NESEN) was established to improve links between K-12 earth-science teachers and the resources and professional expertise at the University of Nebraska-Lincoln (UNL). The Conservation and Survey Division (CSD) of the Institute of Agriculture and Natural Resources at UNL leads this effort.

The NESEN system was introduced to teachers in late 1992. NESEN membership consists of nearly 125 K-12 educators and 50 scientists and post-secondary educators. Teachers tell us they need more information that is timely and relevant to their students — textbooks can no longer keep pace with information and ideas. This information must also be in a usable and understandable format; teachers recognize that they often have a limited understanding of a particular earth-science topic.

The needs and concerns of teachers in Nebraska are not unique, and many solutions have been recommended at national meetings. Solutions vary from state to state and from region to region, depending on educational policies, geographic and population variability (for example, rural vs. urban), monetary and human resources, and equipment and materials. NESEN is using multiple strategies to enhance earth-science education in Nebraska by working directly with teachers. Our strategies include 1) participating in pre-service, in-service and other professional development activities with particular emphasis on the Nebraska Association of Teachers of Science annual meeting; 2) developing workshops on earth-science topics as a basis for lesson-plan development; and 3) enhancing statewide communication, using electronic media.

In a large, rural state like Nebraska, the communication and dissemination of resource materials is challenging. Electronic communication offers a valuable means for cutting across

long distances. But for many teachers, the new technology presents new problems — access, hardware availability, relevance and usability of materials, limitations on the time teachers may have to learn the system, and fear of electronic media.

We are addressing these problems through a variety of initiatives. Soon, access to electronic communication should be available to all teachers in Nebraska. A pilot project, funded by the National Aeronautics and Space Administration (NASA), has extended Internet availability to seven widely spaced rural and urban locations. Educational support is offered in the form of training and educational materials.

Workshops will guide teachers through the electronic network, enabling them to learn how to use the system. NESEN also recognizes that many students are more computer-literate than their teachers and have more time to learn the technology. To take advantage of this situation, a program of reverse mentoring has begun. Student participation will reduce the time teachers need to learn the network system and will reduce their hesitancy about using electronic media.

Educational materials from NASA and those developed through other NESEN activities will be transferred across the network. Although the focus is on developing Nebraska-relevant material, the Internet will also provide teachers with national and international perspectives on natural resources issues.

Electronic technology will play a big role in improving K-12 science education. This technology provides teachers with a mechanism for increasing their knowledge and improving student's access to new experiences. However, technology is a tool and only part of the solution to our educational problems. Many fundamental changes are required within the educational system before these technological tools can be effectively used. More cooperative partnerships and improved communication among earth scientists, science educators, parents, and students are required to improve the quality and effectiveness of science education.

(Contributed by Dave Gosselin, NESEN Project Manager/Research Geochemist, Conservation and Survey Division, University of Nebraska-Lincoln, Lincoln, 68588-0517)

The Nebraska Earth Science Education Network Initiative

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ABSTRACT

The Nebraska Earth Science Education Network (NESEN) was organized in October 1992 and currently has 165 members. NESEN is sponsored by the Conservation and Survey Division (CSD) of the University of Nebraska-Lincoln. To our knowledge, the leadership role that CSD has taken in coordinating a state-wide earth-science-education network is unique among state geological surveys. NESEN has three primary goals, the two most important of which are to: 1) promote and enhance K-12 earth-science education and 2) improve the transfer of earth-science information to the state's K-12 science-teaching community. NESEN has initiated the following activities: a modified lesson-plan share-a-thon; workshops on earth-science topics as a basis for lesson-plan development; a NESEN electronic bulletin board (an opportunity to exchange information using electronic media). NESEN also produces a quarterly newsletter and is an active participant in coalitions formed as part of the Nebraska Math and Science Initiative. Together these activities provide opportunities for earth-science teachers to expand and support their curricula, increase the literacy of the students of Nebraska, and develop a body of technically accurate, up-to-date material that focuses on the special resources of Nebraska.

Keywords: Education - precollege; earth science - teaching and curriculum.

Introduction

Developing practical solutions for environmental and natural resources problems requires a citizenry that is earth-science literate. However, for this to occur, substantial and sustained changes must occur in the existing educational system (AGI, 1991). In 1991, the American Geological Institute's *Earth Science Education for the 21st Century: A Planning Guide* outlined four essential tasks for accomplishing change in earth-science education. The underlying theme was that there must be strong communication among professional earth scientists, science educators, and parents.

The Nebraska Earth Science Education Network (NESEN) was established to provide a mechanism for improving communication and linkages between active K-12 earth-science teachers and resources and professional expertise at the University of Nebraska. The Conservation and Survey Division (CSD) of the University of Nebraska-Lincoln is the lead organization. The

CSD is a multidisciplinary research, public service, and data-collection organization that includes the state geological, water, and soil surveys, as well as a remote sensing group. To our knowledge, the leadership role that CSD has taken in coordinating and sponsoring a state-wide earth-science-education network is unique among state geological surveys.

The main objective of this paper is to describe the development of NESEN and its current activities in providing support for experienced teachers by enhancing and expanding teaching resource materials and educational opportunities. This type of in-service training and support is essential for teachers, many of whom do not have formal training in earth science, and provides a mechanism for enlisting their active participation in promoting the importance of earth-science education through a predominantly rural state. Furthermore, this paper provides a framework that other state geological surveys could use to establish a similar communication network.

Program Development

NESEN was originally conceived in late 1991 by scientists interested in improving the coordination of earth-science-outreach activities at the University of Nebraska-Lincoln. The original group included faculty from CSD and the Department of Geology. Later meetings included representatives from the University of Nebraska State Museum, UNL Teachers College, and a former science-curriculum advisor for the Lincoln Public School system. One of the accomplishments of these meetings was establishing three primary goals for NESEN: 1) to promote and enhance K-12 earth-science education in Nebraska; 2) to help students become better informed about the complexities of environmental and natural-resources problems; and 3) to improve the transfer of earth-science information to the K-12 science-teaching community.

The next step was to determine what activities we would use to accomplish these goals. We initially focused on a number of activities, one of which included partnering, based on the "Partnering for Excellence Program" fostered by the Geological Society of America's Science Awareness through Geoscience Education program (SAGE). This activity would have included the development of a network of speakers, equipped with slides and hands-on materials, who would go to local schools to personalize earth-science issues. Among other activities, we planned to 1) maintain a clearing-house of educational material developed by other organizations, 2) produce kits with hands-on materials highlighting various aspects of earth science (for example, dinosaurs, rocks, minerals, and so on), and 3)

lecture-only activities where teachers are expected to translate concepts into teaching materials. The network promotes mutually beneficial interaction between teachers and professional scientists.

The first strategy employed is providing new material activities and lesson plans that have been successfully used by other earth-science teachers. This provides the opportunity for a teacher to modify and improve his or her instructional materials with minimal effort. The new material enhances their knowledge of other earth-science topics and, hopefully, increases their enthusiasm for earth science. The materials may also expose teachers to new instructional strategies.

The second strategy is to use workshops and field trips to provide the teacher with new knowledge on a specific topic in the context of activities they can use with their students. The teachers working with earth-science mentors who are professional geoscientists can formulate activities to incorporate the acquired knowledge into their curriculum. In addition to the benefits outlined above, enhancing teacher training and experience makes them more cognizant of the practical applications of earth science to society and potentially how it can be related to other disciplines.

Activity Descriptions and Status

NESEN has implemented the following activities:

Activity 1: A Modified Lesson Plan Share-A-Thon at NATS. The model for this activity is the National Earth Science Teachers Association Share-A-Thon where teachers exchange and discuss lesson-plan activities with the authors. The modification is that, before the official exchange occurs, the lesson-plan content is reviewed by NESEN earth scientists.

The first NESEN-sponsored lesson plan share-athon took place at the NATS meeting in October 1993. Although there were only five lesson-plan presenters, which would suggest minimal success, the fact that over 50 copies of each lesson plan were distributed highlights the potentially important role that this format can have on the exchange of student-tested classroom materials. One teacher reported requests for an additional sixty copies.

Activity 2: Workshops and/or Field Trips on Earth-Science Topics as a Basis for Lesson Plan Development. These one- to two-day workshops will combine professional expertise, hands-on experience, and the teachers' pedagogical knowledge. Each workshop/field trip will have a specific focus and teachers will work in groups to develop the materials as lesson plans for their use. Activities will be designed to provide teachers with current technical background and information. Information will also be provided on where and how to get the earth-science data necessary to do some exercises that are relevant to their area. This type of information includes stream-gaging records, soil information, groundwater levels, and meteorological data.

To initiate this activity, a survey of the K-12 NESEN members was conducted to ascertain their interest in potential workshop topics related primarily to

geoscience topics. These included: 1) Understanding the earth in four dimensions; 2) Nebraska's dynamic water system: A geoscientific approach; 3) Rural and urban applications of soil surveys; and 4) What's in rock. Approximately, 30 percent of the surveys were returned and indicated a preference for the water and rock topics.

Two pilot workshops, stressing interactive participation between teachers and presenters, were conducted during the summer of 1994. The pilot programs consisted of the presentation of scientific topics in the form of activities and short field excursions that teachers participated in just as their students would. Although the presenters are knowledgeable about the topic, they did not necessarily have an understanding of the best method of presentation or the age-appropriateness of the material. The pilot program teachers then created activities for their classrooms. The teachers also assisted in reconfiguring the materials presented, and the materials have been made available to other teachers in hardcopy and electronic formats (see below). The teachers also provided the framework for short workshops sessions at the 1994 NATS conference.

Activity 3: Enhancing State-Wide Connectivity and the Exchange of Information Using Electronic Media. The primary purpose of this activity is to enhance the dissemination of and access to earth science materials for teachers. This is particularly important for a large, rural state where long distances commonly prohibit access to resources and materials. To initiate this activity, a NESEN electronic bulletin board has been established on MIDnet, a midwest regional high-speed data communications network, through the Nebraska Research and Education Network. The MIDnet node on Internet (one of only 18 in the United States and hosted by the University of Nebraska-Lincoln) is the largest source of traffic on the NSFNET. The bulletin board acts as an information clearinghouse for teachers who need geoscience information. It provides an opportunity for teachers to: 1) ask specific questions of UNL professionals via electronic mail; 2) receive information on current NESEN activities; 3) receive news of earth-science activities, programs, and resource materials available from UNL, national professional organizations, and government agencies; and 4) participate in a forum for information exchange among teachers across the state.

There are numerous problems with implementing an electronic-communication network among teachers, which in turn reduces the usage of this medium. To develop workable solutions for these problems, a pilot project supported by NASA will extend Internet connectivity to classrooms in seven widely spaced locations (rural and urban) and be combined with adequate educational support.

Workshops will be held at the pilot locations to guide the teachers through the electronic network so that they will be able to use the system. Although the network is being designed for teachers, we recognize

ABSTRACTS WITH PROGRAMS

NEW ORLEANS

BRIDGING THE GULF

1995 Annual Meeting

New Orleans, Louisiana

November 6-9, 1995

Ernest N. Morial Convention Center

11:15 AM Gosselin, David C.

NEBRASKA EARTH SCIENCE EDUCATION NETWORK (NESEN): A STATE GEOLOGICAL SURVEY ENHANCING THE UNIVERSITY-TEACHER CONNECTION.

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The Nebraska Earth Science Education Network (NESEN) was established by the Conservation and Survey Division in 1992 to improve communication between K-12 educators and professional earth scientists. State geological surveys can be particularly effective in this role because of their local expertise, their access to data and publications, and their ability to relate to general audiences. Commonly, surveys also have access and linkages to broader university expertise.

NESEN is using multiple strategies to improve the delivery of timely and relevant earth science information to the K-12 community including: 1) participation in professional development activities with emphasis on the Nebraska Association of Teachers of Science annual meeting; 2) developing workshops on earth science topics utilizing resources available at the survey. Workshops entitled "What's in a Rock", "The Earth in Four Dimensions", "The Rural and Urban Applications of Soil Surveys"; and "Nebraska's Dynamic Water System: A Geoscientific Approach" combine professional expertise, hands-on experiences and the teacher's ability to translate information into lesson plans; and 3) enhancing state-wide communication using electronic media. Through a grant from NASA, Internet connectivity has been extended to seven rural and urban schools to demonstrate that electronic communication with adequate educational support can improve science education.

Current NESEN membership consists of 135 K-12 educators and 55 scientists and post-secondary educators. A quarterly newsletter and resources guide and directory is provided to members. NESEN organized GeoShare at the 1995 joint North Central-South Central sectional GSA meeting the first GeoShare featuring information, programs, and educational materials available from state geological surveys within the section.



The Geological Society of America

Feature Article

NEBRASKA EARTH SCIENCE EDUCATION NETWORK: A UNIVERSITY-TEACHER CONNECTION

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Introduction

Understanding earth systems is required for developing practical solutions for environmental and natural resources problems on local, national and international scales. Improving peoples' understanding of earth systems and, more importantly, general scientific literacy at all levels, requires strong communication between professional earth scientists, science educators, and parents. The Nebraska Earth Science Education Network (NESEN) was developed to provide a mechanism for enhancing linkages between K-12 earth science teachers and the resources and professional expertise at the University of Nebraska-Lincoln (UNL). The Conservation and Survey Division (CSD) of the Institute of Agriculture and Natural Resources at UNL is the lead organization. CSD is a multidisciplinary research, public service, and data-collection organization including the state geological, water, and soil surveys, as well as a center for remote sensing and geographic information systems. State geological surveys, such as CSD, can be particularly effective in enhancing these linkages because of their local expertise, their access to data and publications, and their ability to relate to general audiences. Commonly, surveys also have access and linkages to broader university expertise.

The needs and concerns of Nebraska teachers (Gosselin et al., 1995) are similar to those addressed at numerous education-related meetings (for example, Mayer and Armstrong, 1990; American Geological Institute, 1991; Geary and Zen, 1993; Metzger, 1993). However, implementing solutions vary from state to state, region to region, and on an international scale, country to country, depending on educational policies, geographic and population variability (for example, rural versus urban), monetary and human resources, and available equipment and materials. NESEN employs multiple strategies to enhance and expand earth science

education in Nebraska by working directly with teachers because they are the most effective means of reaching students. These strategies include: 1) participating in pre-service, in-service and other professional-development activities with particular emphasis on the annual state science teachers' meeting (this type of in-service training and support for teachers is essential since many do not have formal training or education in earth science); 2) providing an annual summer workshop series, as well as developing new workshops, on earth science topics as a basis for lesson-plan development (that is, combining the information and expertise available at CSD and UNL with the pedagogical knowledge of teachers into lesson plans and activities that are classroom ready—most of which are available on the NESEN homepage; and 3) enhancing statewide communication using electronic media. It is one of NESEN's goals to electronically transfer across the network Nebraska-relevant earth science educational materials. Although Nebraska-relevant material is the primary objective, the connection to the Internet also provides teachers with access to earth science and other information on a national and international level

NESEN also recognizes that many of its members, especially those in less populated, more rural Nebraska, do not yet have the electronic infrastructure to connect to the Internet. Therefore, NESEN takes appropriate steps to work with these teachers. Some of these steps include: a quarterly newsletter and our annual NESEN Resources Guide and Directory (currently in its third edition). The Guide includes most of the relevant material that is on the NESEN homepage and, as mentioned earlier, extensive participation in the annual Conference.

NESEN currently has nearly 300 members. Of these 300, approximately 230 are K-12 Nebraska earth science teachers and 70 are post-secondary earth science educators from UNL and other post-secondary

institutions within Nebraska. In addition, there are several teachers and post-secondary educators who are members from outside Nebraska.

The purpose of this paper is to: 1) relate our experiences and progress on an electronic-communication pilot project funded by the U.S. National Aeronautics and Space Administration (NASA); and 2) describe a related project, Students and Teachers Exchanging Data, Information, and Ideas (STEDII), that has evolved as part of the grant.

NASA-Funded Electronic Communication Project

Through this project and a variety of other initiatives, including state legislative action, access to electronic connectivity will soon be available to all Nebraska teachers. Although the infrastructure will soon be available, there are numerous problems with implementing an electronic communication network among teachers, which in turn minimizes the effectiveness of this media. These problems include access to electronic media, hardware availability, and compatibility, relevance and usability of materials, limitations on the time teachers have to learn the system, and the participants' apprehensiveness of computers and other electronic media.

The specific objectives of our electronic-communication project are to connect geographically distant classrooms to the Internet and distribute materials and information over the network. Pilot sites were selected to provide: 1) a broad geographic distribution; 2) a range in computer knowledge from novice to a moderate level of expertise; and 3) a range of grade levels from middle school to high school. It was also considered useful if the selected teachers had previous interaction with CSD and/or NESEN staff.

Complete electronic connectivity and/or computer hardware, as well as software support, has been provided to eight pilot schools across Nebraska. In order to help these teachers learn about the electronic network, a workshop was given by CSD and UNL Information Services in March 1995. Although the network focusses on teacher support, we recognize that their students are often more computer-literate and have more time to become familiar with the technology than their teachers. To take advantage of this situation, students also participated in this workshop with the intent of instigating "reverse mentoring". In this program, student participation will reduce the time the teacher needs to learn the system and reduce the hesitancy of teachers to use electronic media. Although this reverse-mentoring process was instigated, its successful implementation was minimized because of varying school policies regarding Internet access by students and the fact that students availability changed from one

semester to the next. In addition to the workshops, NESEN staff have spent variable amounts of time with the participating teachers helping them with computer configurations and hardware installations and addressing teachers' questions about software and network access. We found that providing a computer and access to the electronic super highway was only the beginning of getting teachers on the "Net." The teachers and their schools also needed local in-house technical support that many of them did not have.

To distribute information and materials over the network, we initially established an electronic bulletin board. With the development of the World Wide Web (WWW) and web browsers, we established a homepage (<http://nesen.unl.edu/nesen.html>) that contains detailed information about NESEN. Some of this information includes, but is not limited to: "Ask-a-NESEN-Scientist"; hundreds of earth science activities/lesson plans designed by NESEN teachers and pre-service teachers; lists of earth science materials that can be borrowed by NESEN members; newsletters; earth science announcements; activities, background and benefits of NESEN; information about the Students and Teachers Exchanging Data, Information, and Ideas (STEDII) project and access to STEDII's data entry/retrieval system; an earth science feature of the month; information about the secondary science education program at UNL's Teachers College; and many links to other earth science workstations. New information is being added to the homepage daily. For NESEN teachers who desire an email account, one can be provided to them through NESEN resources.

Interaction via email is common between NESEN members. Approximately 40 percent of NESEN K-12 members and 50 percent of NESEN post-secondary members reported having email addresses. NESEN has created several alias email lists for easy communication with most, or selected parts, of the membership.

The K-12 members with email access were surveyed regarding their interaction with the NESEN homepage and activity with the WWW. Seventy-five percent of the respondents said they knew NESEN had a homepage and approximately 50 percent had visited the site at least once. Inability to connect to the WWW was the primary reason for not visiting the homepage. A few responded that they visit the site at least once a week. Of the schools that can access the WWW 30 percent have teacher-only permission for access and 60 percent have student-supervision access. The remaining 10 percent allow the students to have unsupervised access (usually after some sort of agreement is made between the student and the school about appropriate access on the WWW.) Teachers were also asked if they found material on the WWW useable for their classes. Fifty percent said they found an

adequate amount of information. The remaining 50 percent said that most of the information they found was not suitable for various reasons (for example, too much preparation time required, supplies or equipment not available, supplies or equipment too costly, etc.).

STEDII Project

The STEDII project evolved out of the electronic-communication project as a way to focus the acquisition of educational resources from the Internet and the sharing of these materials with the other pilot sites. The current topic, weather, is ideal because students experience it every day and it is generally quite variable across Nebraska.

Along with the eight pilot schools, six other schools, which are independently electronically-connected, are involved in the project. As part of this project, students learn how to use weather instruments and proper procedures for collecting data. Where needed, NESEN supplied the schools with maximum/minimum thermometers, sling psychrometers (relative humidity instruments), barometers, anemometers (wind-speed instruments), and rain gauges. These instruments allow the students to collect the following data: maximum and minimum temperature, relative humidity, wind-speed and direction, cloud cover, barometric pressure and precipitation. Frequently, data is gathered in small groups in which the students learn teamwork and cooperative learning skills. Having every student in a group taking measurements has the added benefit of reducing the chance of significant error. Students eventually became adept enough at their data-collection activities to recognize "good data" from "bad data," that is, the beginnings of quality control.

Additionally, some of the STEDII teachers use the weather data to teach other skills such as mathematics and statistics (means, modes, and medians), graphing, mapping and simple weather forecasting. Some schools have established weather clubs that continue data collection beyond the weather unit. In fact, several of the local newspapers ran stories about the school's weather-collection activity and reported those data in their respective town newspaper. Students and/or teachers have also explored the possibility of finding partner sites in other parts of the state, country and world with which they could exchange data.

Originally, the data was exchanged between participating schools and the project managers at UNL via email. This added the advantage of students gaining experience and knowledge of email and the Internet. However, this method became mundane and offered little in terms of data use. Later, a homepage was created for STEDII (<http://nesen.unl.edu/stedii/mmesarch/stediihp.html>)—or access may be made directly from the NESEN homepage) whereby data was entered and

retrieved via an on-line form. The students enjoy entering the data via the WWW, which has encouraged them to further explore the resources that the WWW offers.

STEDII has had the bonus of developing a strong relationship with the secondary-science education program at UNL's Teachers College and with its director, Dr. Ron Bonnstetter. As far as we know, this three-way linkage between the resources of a state geological survey, pre-service science teachers and in-service teachers is unique in the United States.

During 1995-96, four pre-service science educators, as part of the requirements of their science methods coursework, participated in STEDII. Each pre-service teacher was assigned two or three participating in-service teachers. The pre-service teachers provided some technical assistance to the teachers and offered ideas for activities using the Internet. In turn, the pre-service teachers were given opportunities and experience in working with practicing earth science teachers and use of the Internet in classroom situations.

The STEDII project has similar components and structure to another school/research interaction group on the Internet, the GLOBE (Global Learning and Observations to Benefit the Environment) project (<http://globe.fsl.noaa.gov/>). GLOBE has many more schools collecting data, but fewer types of weather measurements are taken. With numerous locations collecting data, not every school needs to collect data to provide an adequate spatial and temporal coverage to produce useful activities that allow comparisons between schools.

Program Benefits and Summary

K-12 students are the primary benefactors from NESEN activities, either directly through participation in STEDII or through other teacher-enhancement activities through which their teachers become more knowledgeable, the students will be better informed and more capable of addressing future environmental and natural-resources issues. The NESEN initiatives will provide teachers, many of whom do not have formal training in the earth sciences, the opportunity to get current technical information on Nebraska's natural-resources issues.

Through our projects we have observed that technology can play an important role in improving K-12 education. Electronic technology provides teachers with a mechanism for expanding this knowledge and increasing their students' access to new experiences. However, technology is only a tool and only part of the solution to our educational problems. Many fundamental changes are required within the educational system before these technological tools can be used effectively. Specifically, proper local technical

support must be available to ensure that frustration with the technology does not minimize its classroom implementation. Technical support should apply to both hardware and software. Time must be made available for teachers to not only learn the technology, but to learn what are the best pedagogical approaches for using this technology in the classroom. Addressing these issues is especially important in rural areas where local support may not be readily available. In concert with addressing local support issues, educational materials on the "Net" need to be created that are more user-friendly and focused on specific topics which support current curriculum guidelines, such as the National Science Standards in the United States. Proper development will allow Internet materials to be more efficiently implemented in the classroom. Finally, local cooperative partnerships and communication systems, such as those used by NESEN, are required to improve the quality and effectiveness of science education.

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**OLIN HALL OF SCIENCE - NEBRASKA WESLEYAN UNIVERSITY
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**THE NEBRASKA EARTH SCIENCE EDUCATION NETWORK (NESEN): CONNECTING
UNIVERSITY RESOURCES AND K-12 EARTH SCIENCE EDUCATORS.**

Duane R. Mohlman¹, Mark A. Mesarch², and David C. Gosselin¹, ¹Conservation and Survey Division;
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NESEN was created in 1992 to provide a mechanism for fostering linkages between Nebraska's K-12 earth science teachers and the geoscience expertise at UNL. We believe that this linkage is a key component of improving science education. Through the efforts of many individuals, most importantly K-12 teachers, NESEN has expanded interest in earth science education across the state. K-12 earth science educators consider NESEN an important resource for information on Nebraska's natural resources. K-12 teacher input has been critical to NESEN's success. NESEN currently has 370 members.

NESEN uses many strategies to deliver timely and relevant earth science information to the K-12 community. These include: 1) participating in current professional development activities, with emphasis on the NATS annual meeting; 2) conducting summer workshops on selected earth science topics. These workshops integrate scientific expertise, hands-on experiences and the teacher's ability to translate information into usable lesson plans; 3) enhancing state-wide communication by providing electronic connectivity for eight pilot schools through a grant from NASA; 4) establishing a video tape/CD-ROM lending library; 5) making available materials and activities in a variety of formats; 6) producing a quarterly newsletter; 7) printing an annual *Resources Guide and Membership Directory*; and, 8) maintaining a current and useful NESEN Home Page (<http://nesen.unl.edu/nesen.html>).

In 1995, *Students and Teachers Exchanging Data, Information and Ideas* (STEDII) evolved from the electronic communication project. STEDII focusses on students collecting data, exchanging it with other schools, and using educational resources from the Internet. The current topic, weather, was chosen because it is variable across Nebraska and students experience every day.

Nebraska Earth Science Education Network (NESEN): Connecting University Resources and Earth Science Educators. Gosselin, D. C., Mohlman, D. R., Meyer*, S. J., Mesarch*, M. A. and Lang, B. P., Conservation and Survey Division and *Dept. of Ag. Meteorology, Institute of Agriculture and Natural Resources University of Nebraska-Lincoln, Lincoln, NE 68588.

A key component to any sustainable reform of science education will be improving communication between scientists and K-12 educators. Officially established in January 1993 by the Conservation and Survey Division, NESEN is a mechanism for encouraging cooperative partnerships and improving communication among earth scientists, science educators, and students. Through the efforts of many individuals, and particularly K-12 teachers on our steering committee, NESEN has expanded interest in earth science education across the state. K-12 earth science educators consider NESEN an important resource for earth science information. As of December 1996, NESEN membership was more than 370, a 33% increase from the previous year.

The word network implies the use of electronic media to link educators, but NESEN is about people working with people and using multiple strategies to improve earth science education. The strategies employed to deliver timely and relevant earth science information to the K-12 community include: 1) participating in current professional development activities with emphasis on the Nebraska Association of Teachers of Science (NATS) annual meeting; 2) conducting summer workshops on earth science topics selected based on teacher interest surveys. These workshops integrate scientific expertise, hands-on experiences and the teacher's ability to translate information into lesson plans; 3) enhancing statewide communication by providing electronic connectivity, computers, and other logistical support for eight pilot site schools through a grant from NASA; 4) establishing video tape/CD-ROM lending library; and 5) making available materials and activities in a variety of formats that range from a lesson plan share-a-thon at NATS to a quarterly newsletter to the NESEN homepage (<http://nesen.unl.edu/nesen.html>). In our continuing effort to be inclusive we published our third annual Resources Guide and Membership Directory to give those who do not have access to the World Wide Web the opportunity to obtain information in a more traditional format.

To expand the diversity of our activities, especially in the area of climate/environmental variability and earth systems science, stronger working relationships have developed with the UNL's Department of Agricultural Meteorology and Teacher's College, as well as the U.S. Department of Energy's Great Plains Regional Center for Global Environmental Change. As a result, thirty schools have become involved with the Students and Teachers Exchanging Information and Ideas (STEDII) project, which has students actively collecting, interpreting, and exchanging weather data via the Internet.

Although the NESEN outreach concept has had an impact, there is more to be accomplished. The keys to our continued success will be improving communication with pre-service educators, promoting coevolving curriculum, and creating access to classroom-ready information and data that teachers and students can use to investigate their local earth systems.

Conference Theme/Subtheme:

**Need for Public Literacy in the Earth Sciences/Outreach Programs in Earth Systems/Sciences
Role of Government Agencies in Supporting Educational Efforts/Partnerships with Educators
Role of Government Agencies in Supporting Educational Efforts/Role of Researcher in providing
educational information, materials, and opportunities**

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