COMMUNICATING WEATHER RADAR RESEARCH TO PUBLIC AUDIENCES: THE PROPOSAL

Rachel Butterworth
National Weather Center Research Experiences for Undergraduates
University of Oklahoma, Norman, Oklahoma
Iowa State University, Ames, Iowa

Dr. Kevin Kloesel
Associate Dean, College of Atmospheric and Geographic Sciences
National Weather Center
University of Oklahoma, Norman, Oklahoma

ABSTRACT

Currently the National Science Foundation (NSF) is seeking proposals to communicate NSF-funded research programs to public audiences. The American public generally supports government funded scientific research. However, despite their favorable attitude, Americans are scientifically illiterate. Weather radar is one of the most important tools for both forecasting and meteorological research. It is also a useful tool for the public. It is crucial the public understands at least some of what is being accomplished in regards to weather radar research because one informed decision during a hazardous weather event may mean the difference between life and death. A proposal was written to use video and web-based material to teach the public about weather radar research, past and present. A literature review was conducted across multiple disciplines prior to constructing the proposal in order to determine the most effective way to teach the public about weather radar. In addition, a survey instrument will be used to determine the public's knowledge-level of weather radar; information that will further shape the content of the proposed video and web-based material.

---

1. INTRODUCTION

The National Science Foundation (NSF) is currently requesting proposals to develop education programs that communicate specific NSF-funded research activities to public audiences. The funds are available from the Informal Science Education program (ISE) in the Division of Elementary, Secondary, and Informal Education. ISE projects are designed to provide "rich and stimulating contexts and experiences for individuals of all ages, interests, and backgrounds to increase their appreciation for, and understanding of, science, technology, engineering, and mathematics (STEM) in out-of-school settings" (NSF RFP 2007). The purpose of this paper is to outline the process that was undertaken to craft the attached (Appendix A) proposal to the NSF ISE program.

Motivation for this proposal stems from the desire to use weather radar to save lives in severe and hazardous weather. While meteorological researchers continue to solve complex problems and make technological advancements in the area of radar, many times these advances are not understood or appreciated by the general public. If the public does not know or understand what is occurring in the radar research community, then what the researchers do is in vain. Society should have the chance to learn how to make better decisions with radar in order to benefit their lives. Thus, action needs to be taken in order to help the public learn about advancements being made by radar researchers.

2. BACKGROUND

Communicating weather radar research to public audiences requires several areas of study to be examined. Prior to creating science-based material, one must know and understand pre-existing knowledge and attitudes the American public has regarding scientific issues. One must also determine the best way to communicate scientific information to people who are not familiar with these topics in the first place. In addition, one must discover *how* the public learns scientific information. Finally, if media content is to be based on weather radar research, historical advancements in weather radar along with future technology such as the NSF-funded Collaborative Adaptive Sensing of the Atmosphere (CASA) radar program must be addressed.

2.1 Public Knowledge and Attitudes About Science

Although Americans strongly support government funding for basic scientific research, many Americans do not fully understand the scientific process (Science and Engineering Indicators 2006). In fact, in a 2004

NSF survey, only 23% gave responses indicating they knew what it meant to study something scientifically (Science and Engineering Indicators 2006).

Despite the lack of scientific knowledge among the general public, many people have a high regard for the scientific community. In a 2004 Virginia Commonwealth University Life Sciences survey, 92% of the respondents agreed with the statement "scientific research is essential for improving the quality of human lives" (VCU 2004). In addition, people are more interested in practical science than science policy issues (Science and Engineering Indicators 2006). They want to know how science is going to impact *them*.

It is clear that while Americans have a high regard for the scientific community, there is a disconnect between them and scientists, creating a very large scientific knowledge gap.

2.2 Effective Communication

Television is the main source of information for the general public, but the growth of the Internet continues to change the way material is presented. In 2004, 63% of American adults and 81% of teens were online, and those numbers continue to grow (Rainie et al. 2005). The Internet was also the number one source of information regarding specific scientific issues in 2004 (Science and Engineering Indicators 2006). While the Internet allows for increasingly more access to scientific information, most Americans are not in contact with a scientist on a regular basis. In fact, "TV weathercasters are often the most visible representatives of scientists in U.S. households" (NIST 2002).

In addition, television media is often criticized for being more interested in covering sensationalism when covering science, and media foster negative opinions of science and technology. Nonetheless, the media also frequently portrays scientists as authoritative figures (Nisbet et al. 2002).

If TV and Internet are the largest sources of scientific information, yet the public continues to be scientifically illiterate, a stronger, more direct approach must be taken to engage Americans in scientific research. Modern media is highly visual, so any scientific presentation should contain colorful graphics and visual stimulants. Scientific information also often contains jargon. Thus, it is crucial that any scientific information be clearly presented and any words or acronyms that may be confusing to the general public clearly explained (Hoppen et al. 1996). In addition, the presentation should be practical and any narration cannot come from someone with a monotone voice, as it will only support the scientist stereotype.

2.3 How the Public Learns Scientific Information

It is difficult to only define one or two ways the public learns scientific information. Diverse populations (gender, age, ethnicity, etc.) and a multitude of delivery mechanisms (paper, video, web-based, etc.) yield for challenging work to those trying to understand informal learning processes. Survey articles on scientific literacy (Laugksch 2000), models of pedagogy and epistemology (Matthews 2007), and instructional technology (Hew et al. 2007) indicate that there are as many models and approaches as there are educators. In addition, it has been shown that the same instructor can teach the same material in the same way to a multitude of classes, and experience different learning outcomes (Shulman 1999).

Green and Land (2007) describe the process by which they studied undergraduate students in their pursuit to create web-based content regarding various topics for elementary-aged students. The projects were not necessarily rooted in science, however some of the observed thought processes used by the undergraduate students to accomplish their learning tasks may be of some significance to the scientific teacher. Something to note is that people seem to learn better when personal experiences are involved. In other words, educational questions and concepts need to be put in familiar contexts for the learner. While no other definitive conclusions were made regarding the scientific learning process of the public, it may be important for the content-developer of scientific teaching tools to ask themselves a few questions. These questions include: What will the learner actually be doing? What is the learner to accomplish? In addition, how will the leaner navigate information on the world-wide-web (if applicable) without getting lost (Green and Land 2007)? There must be plenty of structure for the material to be understood.

While some literature exists pertaining to how learning processes are studied, there is a lack of literature relevant to how people actually learn scientific information in an informal setting, especially in relation to weather information. As pointed out in Matthews (2007), "good teachers have long followed Aristotle's pedagogical lead—they start instruction with what is familiar and known, and build to what is unknown" (Matthews 2007). Or, as written in Ausubel, 1968, "to teach a child, find out first what they know and then build upon it" (Ausubel 1968).

2.4 History of Weather Radar and its Societal Benefits

Although the use of radar began with the military around the *beginning* of World War II, it was not officially used for weather purposes until 1945. Even then, the main user of weather radar was the military. People began to realize the benefits of weather radar when the first tornado warning solely based on radar data was issued on April 5, 1956. Not long after, devastating hurricanes led the Weather Bureau (now known as the National Weather Service) to propose a budget to Congress for installation of a new network of radars called the WSR-57 (Weather Surveillance Radar-1957). The first WSR-57 was in place by 1959 and the ability to "detect storms behind intervening rainfall and to observe hurricanes at great distances" was improved (Whiton et al. 1998). Development of the network of WSR-88D (Weather Surveillance Radar-1988 Doppler) radars began in 1988, and the first Doppler weather radar was in place by 1990. The network of 161 WSR-88D's boasted color displays and velocity and interactive capabilities (Whiton et al. 1998). In addition, Simons and Sutter (2005) found that after the installation of the WSR-88D's, tornado fatalities dropped by 45% and injuries by 40%. Furthermore, the mean lead warning time on a tornado increased from 5.3 to 9.3 minutes (Simons and Sutter 2005).

Much advancement in weather radar technology has been made in the past 60 years and society has greatly benefited from them. However, many improvements will still be made. The Multifunction Phased-Array Radar is weather radar technology of the near future. Phased-Array radar will again increase lead warning times on tornadoes, improve rainfall estimates, as well as improve safety for airline travelers (Forsyth et al. 2005).

2.5 CASA and its Societal Benefits

CASA is using weather radars to revolutionize the way we observe, understand and predict severe and hazardous weather. The goal of the CASA program is to be able to sense the lowest 1 km of the atmosphere where most severe and hazardous weather occurs. Currently 72% of this portion of the atmosphere is not sensed due to limitations of the current WSR-88D radar system. CASA uses radars that perform their weather sensing tasks in a Distributed Collaborative Adaptive Sensing (DCAS) way. The idea behind DCAS is that a larger group of smaller radars will address some of the current limitations of the WSR-88D network. There are currently three DCAS test bed sites across the country focused on sensing severe weather (Southwestern Oklahoma), flash flooding (Houston, TX), and tropical rainfall in complex terrain (Puerto Rico). The CASA radars have higher spatial and temporal resolutions than the WSR-88D. That helps all weather radar data users because each is better able to see where a storm will strike or where the most intense rain will fall. Another benefit of CASA is the ability of the radars to collaborate and provide the most pertinent information to specific decision makers at a certain time.

3. METHODOLOGY

As noted in Section 2, research for the NSF proposal was conducted across multiple disciplines. In addition to literature review, eight DVD/interactive website presentations were evaluated to frame ideas for future media content to be created conveying weather radar research to the public. The NSF proposal itself was then developed, addressing non-traditional meteorological research topics such as budget items, media content project design, and project timeline.

4. DISCUSSION AND CONCLUSION

Unique to this research experience is the addition of a survey (Appendix B) which will seek to find out what the public understands about weather radar and how their decision-making skills can be improved. While not in the time-scope of this research experience, the survey will be the underlying theme for an undergraduate senior thesis to be completed at the lead author's home institution. Because the survey is intended to shed light on the public's knowledge of weather radar (something these authors have not been able to find in existing literature), it will be beneficial to the framing of the proposed media content communicating weather radar research to public audiences. However, several challenges arise in this instance.

One challenge is obtaining approval from the Institutional Review Board (IRB) to conduct the survey within each of the two university settings. The IRB is a group charged with protecting the safety and well-being of human research participants. The entire process to receive IRB approval is a rather lengthy and tumultuous path consisting of many pages of documents and an extended waiting period prior to approval. While most scientific research does not need permission to use the data from its source (i.e. a computer), permission IS needed in this case when the source is a human population.

Another challenge the authors face is satisfying the needs and desires of multiple institutions. While one question on the survey may be beneficial to one party, it may not be to the other. And, due to the public's tendency to shut down after a certain amount of time, each survey question must be crafted very carefully.

The ultimate goal is a successful proposal, and only time will tell whether or not the goal is accomplished.

5. ACKNOWLEDGEMENTS

This material is based upon work supported by Oklahoma EPSCoR and National Science Foundation Grant No. ATM-0648566. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of Oklahoma EPSCoR or the National Science Foundation. Special thanks to Dr. Kevin Kloesel for continual support and guidance during research, as well as Daphne LaDue for organizing and directing a wonderful NWC REU experience.

6. REFERENCES

Ausubel, D. P. 1968: *Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Forsyth D. E., J. F. Kimpel, D. S. Zrnic, S. Sandgathe, F. Pfeil, J. F. Heimmer, T. McNellis, J. E. Crain, A. M. Shapiro, J. D. Belville, and W. Benner, 2005: The National Weather Radar Testbed (Phased-Array). [Available online at http://ams.confex.com/ams/pdf papers/21975.pdf.]

Green, B. A., and S. M. Land, 2000: A Qualitative Analysis of Scaffolding Use in a Resource-Based Learning Environment Involving the World Wide Web. *J. Educational Computing Research*, **23(2)**, 151-179.

Hew, F. H., U. Kale, and N. Kim, 2007: Past Research in Instructional Technology: Results of a Content Analysis of Empirical Studies Published in Three Prominent Instructional Technology Journals From the Year 2000 Through 2004. *J. Educational Computing Research*, **36(3)**, 269-300.

Hoppen, S., K. C. Clarke, L. J. Gaydos, and W. Acevado, 1996: Communicating Scientific Findings to the General Public. Third International Conference/Workshop on Integrating GIs and Environmental Modeling, Santa Fe, New Mexico, January 21-25, 1996. Santa Barbara: National Center for Geographic Information and Analysis. [Available online at http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/sf_papers/hoppen_stacy/hoppen etal.html.]

Laugksch, R., 2000: Scientific Literacy: A Conceptual Overview. Science Education, **84(1)**, 71-94.

Matthews, M. R., 2007: Models in science and in science education: An introduction. *Science & Education*, **16**, 647–652.

McLaughlin et al., 2007: *Collaborative Adaptive Sensing of the Atmosphere (CASA) Annual Report*, **1**, 7-32.

National Institue of Standards and Technology (NIST). 2002: Communicating the future: Best practices of communication of science and technology to the public.

National Science Foundation (NSF) 2007: Request for Proposal. Program Solicitation 03-509. Communicating Research to Public Audiences.

Nisbet, M. C., D. A. Scheuffele, J. Shanahan, P. Moy, D. Brossard, and B. V. Lewenstein, 2002: Knowledge, reservations, or promise? A media effects model for public perceptions of science and technology. *Communication Research,* **29**, 584-608.

Rainie, L., S. Fox, J. Horrigan, D. Fallows, A. Lenhart, M. Madden, M. Cornfield, and C. Carter-Sykes, 2005: Internet: The Mainstreaming of Online Life. *Pew Internet and American Life Project,* 58-69.

Science and Engineering Indicators 2006 Chapter 7 Science and Technology: Public Attitudes and Understanding.

Shulman L. S. and P. Hutchings, 1999: The scholarship of teaching: New elaborations, new developments. *Change*, **31**, 10-15.

Simons, K. M. and D. Sutter, 2005: WSR-88D radar, tornado warnings, and tornado casualties. *Wea. Forecasting,* **20**, 301-310.

Virginia Commonwealth University (VCU) Center for Public Policy, 2004: Increasing opposition to cloning, but greater support for embryonic stem cell research. *VCU Life Sciences Survey*. [Available online at http://www.vcu.edu/uns/Releases/2004/oct/VCU%20Life%20Sciences%20Survey-2004-Results.htm.]

Whiton, R. C., P. L. Smith, S. G. Bigler, K. E. Wilk, and A. C. Harbuck, 1998: History of operational use of weather radar by U.S. weather services. Part I: The pre-NEXRAD era. *Wea. Forecasting*, **13**, 219-243.

Whiton, R. C., P. L. Smith, S. G. Bigler, K. E. Wilk, and A. C. Harbuck, 1998: History of operational use of weather radar by U.S. weather services. Part II: Development of operational doppler weather radars. *Wea. Forecasting*, **13**, 24-252.

Appendix A: Proposal

(Currently being completed in collaboration with REU mentor at OU and senior thesis advisor at ISU. Expected completion date is August 27, 2007. Proposal submission via NSF FastLane will occur in September 2007.)

Appendix B: Survey

(Currently being completed in collaboration with REU mentor at OU and senior thesis advisor at ISU. Expected completion date will depend on IRB approval at both universities.)

NOTE: THIS IS A DRAFT. THIS IS NOT THE FINAL VERSION.

Radar Survey

The purpose of this survey is to find out how much the general public knows about radar. Please answer the questions below. Your responses are greatly appreciated, thank you!

1. Prior to this survey, had you *heard* of Doppler radar before? (circle one)
   a. Yes   b. No

If *Yes* , please circle *all* of the sources of your knowledge about Doppler radar:
   a. TV   b. school   c. parent   d. friend   e. learning on your own   f. the Internet   g. other (please list):

____

2. Prior to this survey, had you *seen* a radar image before? (circle one)
   a. Yes   b. No

If *Yes*, please circle *all* of the places you have *seen* a radar image:
   a. local TV news station   b. cable TV news station (i.e. CNN, The Weather Channel, etc…)
   c. on a cell phone   d. National Weather Service (NWS) website   e. other website (please list):

____

3. You think a storm may be headed in your direction. Would you actively seek to *use* radar information?
   a. Yes   b. No

If Yes, on the lines below, please rank the choices from 1 to 5, where 1 is the most likely place for you to get radar information and 5 is the least likely place for you to get radar information:
   _____ local TV news station
   _____ cable TV news station (i.e. CNN, The Weather Channel, etc…)
   _____ on a cell phone
   _____ National Weather Service (NWS) website
   _____ other website (i.e. weather.com, accuweather.com, wunderground.com)

4. What do meteorologists use Doppler radar for? (circle all that apply)
   a. finding clouds   b. measuring aerosols   c. measuring precipitation   d. locating radiation   e. measuring CO_2
   f. forecasting weather   g. tracking hurricanes   h. locating tornadoes   i. locating severe/damaging winds

5. Of the colors listed, which is usually indicative of the *highest* intensity on the Doppler radar? (circle one)
   a. blue   b. orange   c. green   d. yellow   e. red

6. Of the colors listed, which is usually indicative of the *lowest* intensity on the Doppler radar? (circle one)
   a. blue   b. orange   c. green   d. yellow   e. red

7. There are 155 Doppler radars across the United States. What are some of the ***limitations*** of the current Doppler radar system? **(circle all that apply)**

a. The curvature of the Earth affects its ability to scan near the ground at distances far away from the radar site.
b. There are some areas in the United States that are not covered by radar scans. (i.e.: the U.S. doesn't have full coverage)
c. Radar data cannot be seen when it is dark outside.
d. The resolution is not always high enough to be able to detect small-scale features such as tornadoes.
e. The radar data is only updated once every hour so it is very difficult to track storms.

8. If the National Weather Service wanted to put a Doppler radar in your backyard, how worried would you be that it would be harmful to you and your family? Circle your level of apprehension on a scale of **1 to 5** where **1** means would be **extremely worried** and 5 means you would **not be worried** at all. **(circle one)**

1 2 3 4 5

9. Two images are printed below; **Image A** and **Image B**. One the lines below, please write in the severe weather phenomenon associated with each image. **(If you are unsure, that is OK, just take a guess.)**

Image A

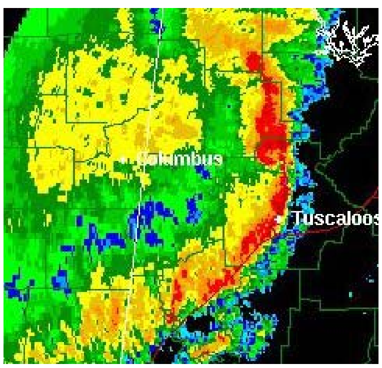
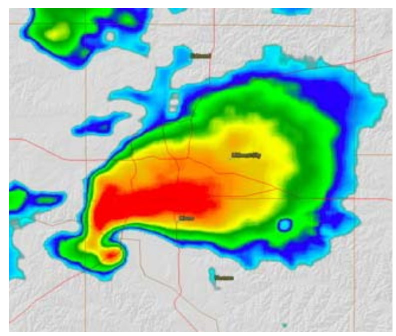
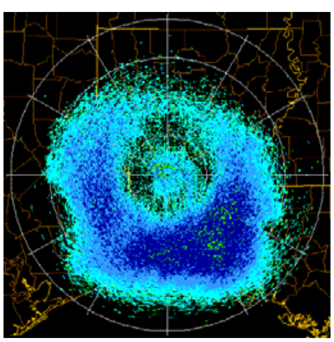


Image B



A: ______________________________ B: ______________________________

10. What is the radar image below showing? **(circle all that apply)**



a. Light rain
b. Heavy rain
c. Ground clutter
d. Non-precipitating echoes (i.e. insects, birds, bats, dust particles)
e. Nothing; the radar is malfunctioning

11. If you had the opportunity to use radar information, would you: **(circle one)**

a. View a still radar image b. View an animated radar image c. No preference

12. Please rank the importance of the following current research programs in radar technology, where 1 is the most important and 5 is the least important? (circle one)

_____ Better precipitation estimates to improve flash flood predictions.
_____ Better knowledge about hail, including where it will fall and how large it will be.
_____ Better knowledge of what kind of precipitation will fall (rain vs. sleet vs. freezing rain vs. snow).
_____ Better detection of tornadoes to improve lead warning times.
_____ Other (please explain):____

13. Your age group (circle one):

a. 18–29 b. 30–49 c. 50–64 d. 65+

14. Your gender (circle one):

a. M b. F

15. In your own opinion, what is your scientific knowledge level? (circle one)

a. Poor b. Fair c. Good d. Exceptional

16. What is your highest academic level completed? (circle one) In addition, on the lines below each choice, write the name of the state (i.e. Oregon, Arizona) you lived in during the time of your respective education, if applicable.

a. High School	b. GED	c. Undergraduate Degree	d. Graduate Degree	e. PhD
a.____________	b. ____________	c. ____________	d. ____________	e. __________

17. If you are in college, what is your area of study? (circle one)

a. Agriculture and Life Sciences b. Business c. Design d. Engineering e. Human Sciences
f. Liberal Arts and Sciences g. Veterinary Medicine