2014 Climate & Society Graduate Fellows Program

Achieving Scientific Literacy in the Classroom: A Climate Science and Law Curriculum

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Executive Summary

Law increasingly demands science to answer key questions in a trial, but the intersection of the two disciplines extends far beyond the courtroom. Much of the legal community does not have scientific training, even though basic scientific literacy is important for many fields of law. The idea for this project originated from my past work experience as a policy analyst and witnessing the communication and knowledge gap between scientists and policymakers. It pointed clearly to the need to fill this gap at an early stage of professional career—namely, as part of legal education.

The purpose of this project is to develop a curriculum for law students that integrates science and the law. Both law and science professors were queried regarding the most important scientific topics to teach that were related to law. Based on these discussions and review of readily available curricula and literature on scientific literacy skills, the curriculum topics for this project were identified, revised, and edited to fit the constraints of the University of Arizona James E. Rogers College of Law Spring 2015, post-February Bar schedule. Readings and other class material were identified to accompany the in-class lectures and discussion.

This project resulted in two significant final outputs: the final curriculum and a class offered at the College of Law, LAW 6980: Integrating Science and the Law in Practice. I will teach and facilitate the class at the UA College of Law during the Spring 2015 semester. The curriculum is a transferrable template for law schools across the country, and the class is the first of its kind to be taught at the UA College of Law. The goal of the curriculum is to introduce students to the scientific context they may encounter in practice and to familiarize them with basic scientific principles to enhance their professional careers. The class will consist of lectures and readings, in addition to experiential learning activities that combine questions of science and law in a professional legal context. Lowering the boundary between science and law by teaching basic scientific literacy skills to law students will promote the two-way flow of information between these critical disciplines.

Key lessons from this project include: the value of a few, in-depth, and high quality responses from experienced educators over a high quantity but standardized responses to an impersonal survey; the nature of use-inspired research as on going and evolving with a fluid, two-way exchange of information; and the support for and usefulness of teaching scientific literacy skills in the legal sphere. The next steps for this project are to teach and evaluate the curriculum and to consider how scientists might benefit from learning legal literacy skills.

Introduction

Law increasingly demands science to answer key questions, and the overlap of the two disciplines extends far beyond the courtroom. It covers agriculture, land use, intellectual property, energy, endangered species, water, and more recently climate change. Beyond the courtroom, lawmakers and agency staff at all levels balance myriad factors when passing laws or making decisions, and a solid foundation in science often makes these actions possible. Boundaries nevertheless remain to distinguish and demarcate the two disciplines (Cash et al. 2002). The boundary between science and the law originates in the very different nature of the two fields: science values empiricism, independence, skepticism, and progress; law captures ideals such as fairness, justice, finality, and predictability (Meazell 2009). This contrast is expressed by Faigman (2000):

> The law's prestige depends largely on adhering to the traditions of the past, while science's prestige turns on how swiftly it advances into the future. But their incompatibility is even more fundamental. Science and law approach the world in profoundly different ways… Science explores what is; the law dictates what ought to be. Science builds on experience; the law rests on it. Science welcomes innovation, creativity, and challenges to the status quo; the law cherishes the status quo.

Whereas science is a consensus-based process that continually builds on itself, litigation is an adversarial process that exploits uncertainties and gaps in knowledge to advantage one side (Jasanoff 2005). The point of litigation is to determine the winner by the end of a time-limited trial, which necessarily precludes a full understanding of the scientific issues and frequently pits equally qualified experts against one another (Meazell 2009).

Much of the legal community does not have formal scientific training (Adler 2003; Posner 2013). According to a recent analysis, of more than 140 college majors identified, the most popular major among law school applicants was political science (21.3 percent), followed by English (6.1 percent), psychology (5.7 percent), and history (5.5 percent) (Muller 2014). Lacking basic understanding of how the scientific process generates knowledge may lead to difficulty accepting some of the fundamental tenets of science, such as uncertainty and the evolving state of knowledge (Adler 2003).

The difference between scientific literacy and scientific knowledge is important. The 1996 definition by the National Research Council in its *National Science Education Standards* is helpful in distinguishing the two:

> Scientific literacy "means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences…. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions…. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it" (NRC 1996).

Researchers have divided scientific literacy skills into both process skills, or understanding and identifying the process of scientific inquiry, and substantive skills, or the ability to analyze and interpret quantitative data and fit that information into the broader questions of a particular topic (Gormally et al. 2012; Krontiris-Litowitz 2013). In contrast, scientific knowledge pertains to

understanding the substantive information, theories, and principles of a specific discipline, such as climatology, dendrochronology, or water quality.

Having basic scientific literacy skills is important for practicing law, regardless of in what capacity or field. As U.S. Supreme Court Justice Stephen Breyer wrote, "The legal disputes before us increasingly involve the principles and tools of science… Our decisions should reflect a proper scientific and technical understanding so that the law can respond to the needs of the public" (Breyer 2011). A short list of disputes that arise in courtrooms across the United States includes agency decisions' about the safety of a drug, the risks of disposing nuclear waste, and the listing of an endangered species, and the impact of an extractive industry on water quality. In the courtroom, scientific information is introduced not only by the parties in dispute but also through *amicus curae* briefs from interested parties, who introduce scientific information as it pertains to their positions in an adversarial search for fairness and a specific truth (Liptak 2014).

As described by the U.S. Supreme Court in Daubert v. Merrell Dow Pharmaceuticals, Inc. (509 U.S. 579 (1993)), one of the primary responsibilities of a judge is to act as a gatekeeper of scientific knowledge that is introduced in the courtroom. In federal court, the standard for the admissibility of scientific testimony by an expert is known as the *Daubert* standard. An expert witness is distinct from a lay witness: A lay witness is limited in testifying to information of which she has firsthand knowledge. An expert witness has greater freedom and may testify to inferences and opinions that relate to the ultimate issues in the case. An expert may also draw conclusions from data that she did not personally collect or obtain (Federal Rules of Evidence 704(a)).

Writing for the majority opinion in *Daubert*, Chief Justice William Rehnquist defined "scientific" to mean grounded in the methods and procedures of science and "knowledge" as known facts, ideas inferred from known facts, or accepted as truth on good grounds, and more than a subjective belief or unsupported speculation. 509 U.S. at 580. Collectively the "scientific knowledge" requirement led to a four-pronged test: (1) whether the scientific theory or technique has been tested empirically; (2) whether a theory or technique has been subjected to peer review and publication; (3) whether there exists and are maintained standards controlling the technique's operation; and (4) whether the theory or technique is generally accepted. 509 U.S. at 593-594. As a result of this ruling, all federal courts are bound to *Daubert* and two other cases that followed. The majority of state courts follow *Daubert* as well, but some still follow a previous standard or have their own standards.

Outside of the judicial branch, the flow of scientific information into the law and lawmaking process also occurs in the legislative and executive branches of government at every level. In the legislative branch, members of Congress often rely on staffers who specialize in science-related areas, as well as outside groups that provide information. These groups may represent a variety of interests and may advocate science favorable to their position. In the executive branch, the President, governors, and agencies rely on scientific advisors or scientific research teams. Agencies are frequently required to seek public notice-and-comment for proposed rules and regulations, giving scientists an opportunity to offer relevant information. Legislation may also require those agencies to explicitly consider scientific data (Doremus 1997).

As members of the public, lawyers are susceptible to the frequent miscommunication of scientific findings and research in media coverage. Research in the past few decades has revealed a theory of cultural cognition, particularly as it applies to perceptions of science and scientific consensus (Kahan et al. 2011). This research suggests that more scientific knowledge will not in fact resolve important policy debates because of the very personal way the public perceives

scientific information. The theory of cultural cognition posits that an individual tends to believe information that fits her worldview and is "psychologically disposed to believe that behavior they… find honorable is socially beneficial and behavior that they find base [is] socially detrimental" (Kahan et al. 2011). Teaching science in a formal, dynamic, and engaging manner has the potential to leave a lasting cultural imprint on these future lawyers, policymakers, advisors, and lawmakers.

Project Design and Methods

The purpose of this project is to develop a curriculum for law students that integrates science and the law. It originated from my past work experience as a policy analyst at the Center for Progressive Reform, an environmental and natural resource law and policy think-tank in Washington, D.C. On several occasions, witnessing the communication and knowledge gap between scientists and policymakers was evident and frustrating, and it pointed clearly to the need to fill this gap at an early stage of professional career—namely, as part of legal education.

Although a handful of law schools around the country offer climate law classes, few if any of these classes place an equal emphasis on teaching skills fundamental to being scientifically literate. Prominent climate change legal experts such Michael Gerrard, Daniel Farber, and William Rodgers devote one or two classes to the trends and projected impacts of climate change and then delve into the legal questions. The premise of this curriculum is that simply knowing the trends and projected impacts of climate change is insufficient. The goal is to expose students to the process and methods of scientific inquiry in a climate context, taking advantage of the active climate science research community at the University of Arizona.

The original project design involved two components: first to conduct three surveys to help determine the topics for the curriculum and then to develop the final curriculum. For the survey component, survey respondents were to include law students at the University of Arizona James E. Rogers College of Law law students; environmental and natural resources law professors across the country who are Member Scholars of the Center for Progressive Reform; and science professors in various departments at the University of Arizona. The final curriculum topics were to be determined by a combination of frequency of responses, a review of the literature on scientific literacy and science in a legal context, and personal judgment. After the topics were identified, readings to accompany the in-class topics were to be identified and assembled.

Partway into the fellowship year, the project design was altered significantly. This change occurred because the deadline to submit a course proposal to the College of Law for the Spring 2015 semester was August 8, 2014. Thus, law students were not given a survey, and the survey for both science and law professors transformed into both telephone sessions and in-person meetings. Based on these discussions, the curriculum topics were identified, revised, and edited to fit the constraints of the College of Law schedule.

Target Audience & Stakeholders

This project was designed to target the legal community and, specifically, law students at the College of Law. Key advisers for this project were Connie Woodhouse and Kirsten Engel, Associate Dean for Academic Affairs at the College of Law. Appendix B lists other key advisors.

The original project design included three surveys to elicit different information from the target audience and different stakeholders for developing the curriculum:

(1) From law students: The level of science education entering law school; the comfort level with science that arises in laws or case laws; their perspective on how important it is to understand basic concepts of science; which topics are important to understand; and their interest level in a class that integrates climate science and climate law.

(2) From law professors: What climate science and general science topics arise in environmental and natural resources resources laws and cases; whether a basic scientific overview would be useful to understanding the law.

(3) From science professors: The key scientific concepts that a well-educated lay professional should understand; the key climate concepts that a lawyer should understand; and the key scientific literacy skills that a well-educated lay professional should possess.

As noted above, the original surveys were ultimately not conducted. However, meeting with or speaking to law and science professors produced much of the same information with better quality and nuance for this project. The information from law students will be obtained from pre- and post-class knowledge surveys.

Outputs

This project resulted in two significant final outputs: a curriculum for integrating science (Appendix A) and the law and an official class, LAW 6980: Integrating Science and the Law in Practice. I will teach and facilitate the class at the UA College of Law during the Spring 2015 semester. The curriculum is a transferrable template for law schools across the country, and the class is the first of its kind to be taught at the UA College of Law. The class will meet during the post-February Bar period, an eight-week session from March 2 to May 1, 2015. The class will meet on Tuesdays from 3:30 pm to 5:00 pm. To date, the class is full with 12 students.

The curriculum focuses on teaching basic scientific literacy skills, namely understanding the process of scientific inquiry and gaining basic data interpretation skills. The goal of the curriculum is to introduce students to the scientific context they may encounter in practice and to familiarize them with basic scientific principles to enhance their professional careers. The course will consist of lectures and readings, in addition to experiential learning activities that combine questions of science and law in a professional legal context. This course will teach students practical scientific skills, orienting them in the complex scientific landscape in which law occurs. Ultimately, the expectation is not that students will suddenly become scientist, but that they will gain a basic understanding of science as they begin their legal careers.

The course syllabus (Appendix A) identifies as the goals of the class:

(1) Students will learn where science enters the legal process and how it is used: in the courtroom; in the legislative context; and in the administrative context.

(2) Students will understand the basic hallmarks of science and gain basic scientific literacy skills and apply these skills in a legal context.

(3) Students will learn the basics of climate science and how it intersects with law in the context of ongoing climate litigation in the United States.

The class will cover the following topics:

- How law and science intersect and interact;
- The hallmarks of scientific knowledge and the process of scientific inquiry;
- Communication and public perceptions of science;
- Understanding data, sources of uncertainty, and interpreting graphs and other visualizations of data;
- Climate science and global climate processes;
- Climate change in the Southwest; and
- Climate change litigation in the United States.

A key feature of this class is experiential activities that will allow students to apply the material and skills taught in this course. Students will assume the role of a lawyer, judge, or legal advisor confronting a question of science in a professional legal context. For example, the experiential activity following the discussion of science as a field of study, students will be asked to assume the role of a judge to consider whether to admit expert witness testimony, based on *Daubert* factors and an understanding of what makes a scientific study credible and reliable. In another class, they will be given a graph and asked to interpret it as a legal advisor to a lawmaker.

A major benefit of this project is its wide applicability to many different audiences. The primary audience is the law students who are interested in environmental and climate change law. Because this curriculum is scalable, however, other audiences include the wider legal community in Arizona and across the country through Continuing Legal Education classes or workshops. The curriculum could be adopted for judicial education workshops, attended by judges and their law clerks.

Main Outcomes

The primary outcomes of this project include:

(1) Law students achieve basic scientific literacy in climate science and related fields. This curriculum will cultivate critical thinking skills to help law students prepare for successful legal careers.

(2) Legal community increases awareness of the need for scientific literacy. Part of this project is to fulfill the longstanding recognition that lawyers need broader training in the fields to which law applies.

(3) I gain meaningful experience as an adjunct professor in teaching students about the practical linkages between science and the law and in developing curriculum that interests and engages students.

To ascertain the achievement of the first outcome, the course will include a pre- and post-class knowledge survey. These surveys are based on the surveys developed as part of the original project design. In addition, the experiential activities will help determine whether students are achieving both the outcome and the intended goals of the class.

Achieving the remaining two outcomes is more difficult to qualitatively ascertain, namely because they are somewhat nebulous and require a longer period to evaluate. When interviewing and speaking with law professors, there was a general recognition and broad support for this course. For example, Professor William L. Andreen sent me notes from a panel discussion more than a decade ago that addressed the integration of scientific and legal education. Other professors and lawyers with whom I spoke were also very supportive.

On a personal level, I have gained a more solid foundation to pursue a career at the intersection of law and science. Both the CLIMAS fellowship and my graduate studies have lent strength to this foundation, and the teaching experience—made possible through this fellowship—will further strengthen it. I am extremely grateful for the opportunity that CLIMAS and this Fellows Program has given me.

Lessons from Use-Inspired Research

The primary lesson learned from developing this curriculum is that use-inspired work is an ongoing, evolving process that does not have a natural stopping point. This work is difficult to structure: What is the relationship between the researcher and the users? How does that relationship begin? How do ideas flow between the two, and how do they determine which ideas get implemented or selected for further development?

Partway through the fellowship period, I learned that the deadline for proposing classes for the Spring 2015 semester was in August 2014. This deadline forced me to restructure the original work plan and timeline and forgo the surveys to develop the curriculum. In some ways, however, this forced expediency complemented another important lesson regarding curriculum input: The quality of input, from talking with a few experienced law professors, is much preferable to quantity of input, from a survey distributed to many, impersonally and by email. Here, the limits of a survey became apparent, particularly when surveying law professors. Conveying on paper the goals and purposes of the class, beyond basic information, limited the nuance of the responses and the back-and-forth exchange that helped me develop and think differently about the curriculum. In addition, a mass survey of topics had the potential to identify myriad topics that probably would not have been feasible to teach.

Another important discovery during the fellowship period is the amount and diversity of interest in bridging the world of law and policymaking and the world of science. With the Republican takeover of Congress in the 2014 elections, the chair of the Senate Environment and Public Works Committee is James Inhofe, who has declared climate change to be the greatest hoax perpetuated on mankind. At the same time, President Obama in his 2015 State of the Union Address said that, when addressing climate change, “I’ve heard some folks try to dodge the evidence by saying they’re not scientists; that we don’t have enough information to act. Well, I’m not a scientist, either. But you know what, I know a lot of really good scientists at NASA, and at NOAA, and at our major universities.” Crossing the boundary between science and law by giving law students basic orientation in the world of science will go a long way toward accepting and acting on scientific findings in their legal career.

Among professors I spoke with, including those who teach somewhat similar law and science seminars and those who teach environmental and natural resources law, there is also interest at law schools in preparing students to better bridge the gap between science and the law and to better prepare students for the real-world context in which law functions.

Next Steps

The next steps for this project are to teach the class, which begins on Tuesday, March 3, 2015. As noted above, students will be given both pre- and post-class knowledge surveys to gauge level of knowledge and understanding gained. If the class is successful and proves interesting for students, the intention is that another adjunct professor might adopt the class with the existing structure and materials in place. I am relocating to Birmingham, Alabama, at the end of June 2015, where I will attempt to replicate this curriculum at one of the three Birmingham-area law schools.

Another significant next step is to begin considering how to broaden the flow of information in the opposite direction, namely teaching legal literacy skills to scientists. As I continue to pursue this career path at the intersection of law and science, I will continue working to promote better flow of information between the two disciplines.

References

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Appendix A

Integrating Science and the Law in Practice[1]

Spring 2015/LAW 6980

Yee Huang, huanglingyee@email.arizona.edu

Legal and policy questions increasingly demand answers from science, whether to resolve a question of causation or to determine a new regulatory action. The docket for the U.S. Supreme Court includes cases on biotechnology, climate change, and water rights, among other science-related issues. In practice, a lawyer may encounter scientific issues in equally diverse fields. To ask critical and informed questions as a lawyer, it is important to have basic exposure to science and to develop scientific literacy skills.

In this eight-week course, students will:

(1) Learn where and how science applies to law: in the courtroom, in the legislative context, and in the administrative context.

(2) Understand the hallmarks of science and scientific inquiry, gain basic scientific literacy skills, and apply these skills in a legal context.

(3) Learn the basics of climate science and how it is used in climate litigation in the United States.

Course Schedule and Topics

This class will meet from 3:30-5:00 pm on Tuesdays. Classes will consist of a combination of lectures from scientific and legal experts, experiential activities, and discussion.

- March 3 Introduction, How Law and Science Intersect and Interact
- March 10 Science as a Field of Study
- March 24 Scientific Inquiry and Public Perceptions of Science
- March 31 Interpreting Data, Part I
- April 7 Interpreting Data, Part II
- April 14 Climate Science and the Global Climate Processes
- April 21 Climate Change in the Southwest
- April 28 Climate Change Litigation in the United States

Course Materials

The materials for this course include a variety of readings from the legal and scientific literature as well as popular media, links to which will be posted online. Below is a sample of selected readings and references.

- Stephen Breyer, "Introduction," in REFERENCE MANUAL ON SCIENTIFIC EVIDENCE. Washington, D.C.: The National Academies Press, 2011. Available here.

- Adam Liptak, *Seeking Facts, Justices Settle for what Briefs Tell Them*, NYT at A10 (September 2, 2014). Available here.

[1] Note: The syllabus in this Appendix is a draft version only and will be updated with a completed syllabus and class materials after the end of the Spring 2015 semester.

- Naomi Oreskes. Why We Should Believe in Science. TED Talks (May 2014). Available here.

- The Daily Show, "An Outbreak of Liberal Idiocy" (June 2, 2014). Available here.

- Intergovernmental Panel on Climate Change. "Summary for Policymakers" in THE PHYSICAL SCIENCE BASIS Fifth Assessment Report. Available here.

- U.S. Climate Change Litigation Chart. Available here.

A complete list of readings will be available in mid-February.

Course Requirements

(1) *Attendance*. Because of the limited number of class meetings, on-time attendance at all classes is required. Exceptions will be made on an individual basis.

(2) *Weekly readings and responses*. Students are expected to respond to a set of questions prior to the start of each class. The questions will be related to the upcoming week's readings, and students may include their own questions in the responses. Responses are limited to 200 words per question and must be submitted to the instructor by noon on Mondays.

(3) *Experiential Learning Activities*. Students are required to complete four experiential learning activities throughout the semester. These activities will give students the opportunity to assume the role of a lawyer, judge, or legal advisor confronting a question of science in a professional legal context and to apply the knowledge and skills gained in class.

Grading

This class is graded on a pass-fail basis, weighing the following components:

- Participation	30 %
- Weekly Responses	20 %
- Experiential Learning Activities	50 %

Office Hours

TBD

Special Accommodations

If you have any special accommodations or needs, please contact Willie Jordan-Curtis, the Assistant Dean of Student Affairs, jordancurtis@law.arizona.edu.

Appendix B: Key Professors and Colleagues

The following professors and colleagues provided helpful advice and insight for developing this project:

- William L. Andreen, Edgar L. Clarkson Professor of Law, University of Alabama School of Law
- Judith Bronstein, University Distinguished Professor, Department of Ecology and Evolutionary Biology, University of Arizona
- Mike Crimmins, Associate Professor, Department of Soil, Water, and Environmental Science, University of Arizona
- Holly Doremus, James H. House and Hiram H. Hurd Professor of Environmental Regulation, Berkeley Law
- Kirsten Engel, Associate Dean for Academic Affairs and Charles E. Ares Professor of Law, James E. Rogers College of Law, University of Arizona
- Christopher Fullerton, Attorney
- Jean McClain, Associate Director, UA Water Resources Research Center, and Associate Research Scientist, Department of Soil, Water, and Environmental Science, University of Arizona
- Erin Steiner, Economist
- Wendy Wagner, Joe A. Worsham Centennial Professor, University of Texas School of Law
- Connie Woodhouse, Professor and Interim Head, School of Geography and Development, University of Arizona