Chapter 2
Educating Public Managers and Policy Analysts in an Era of Informatics

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Abstract In this chapter, two ideal types of practitioners who may use or create policy informatics projects, programs, or platforms are introduced: the policy informatics-savvy public manager and the policy informatics analyst. Drawing from our experiences in teaching an informatics-friendly graduate curriculum, we discuss the range of learning competencies needed for traditional public managers and policy informatics-oriented analysts to thrive in an era of informatics. The chapter begins by describing the two different types of students who are, or can be touched by, policy informatics-friendly competencies, skills, and attitudes. Competencies ranging from those who may be users of policy informatics and sponsors of policy informatics projects and programs to those analysts designing and executing policy informatics projects and programs will be addressed. The chapter concludes with an illustration of how one Master of Public Administration (MPA) program with a policy informatics-friendly mission, a core curriculum that touches on policy informatics applications, and a series of program electives that allows students to develop analysis and modeling skills, designates its informatics-oriented competencies.

2.1 Introduction

The range of policy informatics opportunities highlighted in this volume will require future generations of public managers and policy analysts to adapt to the opportunities and challenges posed by big data and increasing computational modeling capacities afforded by the rapid growth in information technologies. It will be up to the field's Master of Public Administration (MPA) and Master of Public Policy (MPP) programs to provide this next generation with the tools needed to harness the wealth of data, information, and knowledge increasingly at the disposal of public

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administrators and policy analysts. In this chapter, we discuss the role of policy informatics in the development of present and future public managers and policy analysts. Drawing from our experiences in teaching an informatics-friendly graduate curriculum, we discuss the range of learning competencies needed for traditional public managers and policy informatics-oriented analysts to thrive in an era of informatics. The chapter begins by describing the two different types of students who are, or can be touched by, policy informatics-friendly competencies, skills, and attitudes. Competencies ranging from those who may be users of policy informatics and sponsors of policy informatics projects and programs to those analysts designing and executing policy informatics projects and programs will be addressed. The chapter concludes with an illustration of how one MPA program with a policy informatics-friendly mission, a core curriculum that touches on policy informatics applications, and a series of program electives that allows students to develop analysis and modeling skills, designates its informatics-oriented competencies.

2.2   Two Types of Practitioner Orientations to Policy Informatics

Drawn from our experience, we find that there are two "ideal types" of policy informatics practitioner, each requiring greater and greater levels of technical mastery of analytics techniques and approaches. These ideal types are: policy informatics-savvy public managers and policy informatics analysts.

A policy informatics-savvy public manager may take on one of two possible roles relative to policy informatics projects, programs, or platforms. They may play instrumental roles in catalyzing and implementing informatics initiatives on behalf of their organizations, agencies, or institutions. In the manner, they may work with technical experts (analysts) to envision possible uses for data, visualizations, simulations, and the like. Public managers may also be in the role of using policy informatics projects, programs, or platforms. They may be in positions to use these initiatives to ground decision making, allocate resources, and otherwise guide the performance of their organizations.

A policy informatics analyst is a person who is positioned to actually execute a policy informatics initiative. They may be referred to as analysts, researchers, modelers, or programmers and provide the technical assistance needed to analyze databases, build and run models, simulations, and otherwise construct useful and effective policy informatics projects, programs, or platforms.

To succeed in either and both roles, managers and analysts will require a certain set of skills, knowledge, or competencies. Drawing on some of the prevailing literature and our own experiences, we lay out an initial list of potential competencies for consideration.

2.2.1 Policy Informatics-Savvy Public Managers

To successfully harness policy informatics, public managers will likely *not* need to know how to explicitly build models or manipulate big data. Instead, they will need to know what kinds of questions that policy informatics projects or programs can answer or not answer. They will need to know how to contract with and/or manage data managers, policy analysts, and modelers. They will need to be savvy consumers of data analysis and computational models, but not necessarily need to know how to technically execute them. Policy informatics projects, programs, and platforms are designed and executed in some ways, as any large-scale, complex project.

In writing about the stages of informatics project development using "big data," DeSouza lays out project development along three stages: planning, execution, and postimplementation. Throughout the project life cycle, he emphasizes the role of understanding the prevailing policy and legal environment, the need to venture into coalition building, the importance of communicating the broader opportunities afforded by the project, the need to develop performance indicators, and the importance of lining up adequate financial and human resources (2014).

Framing what traditional public managers need to know and do to effectively interface with policy informatics projects and programs requires an ability to be a "systems thinker," an effective evaluator, a capacity to integrate informatics into performance and financial management systems, effective communication skills, and a capacity to draw on social media, information technology, and e-governance approaches to achieve common objectives. We briefly review each of these capacities below.

Systems Thinking Knowing the right kinds of questions that may be asked through policy informatics projects and programs requires public managers to possess a "systems" view. Much has been written about the importance of "systems thinking" for public managers (Katz and Kahn 1978; Stacey 2001; Senge 1990; Korton 2001). Taking a systems perspective allows public managers to understand the relationship between the "whole" and the "parts." Systems-oriented public managers will possess a level of situational awareness (Endsley 1995) that allows them to see and understand patterns of interaction and anticipate future events and orientations. Situational awareness allows public mangers to understand and evaluate where data are coming from, how best data are interpreted, and the kinds of assumptions being used in specific interpretations (Koliba et al. 2011). The concept of system thinking laid out here can be associated with the notion of transition management (Loorbach 2007).

Process Orientations to Public Policy The capacity to view the policy making and implementation process as a *process* that involves certain levels of coordination and conflict between policy actors is of critical importance for policy informatics-savvy public managers and analysts. Understanding how data are used to frame problems and policy solutions, how complex governance arrangements impact policy implementation (Koliba et al. 2010), and how data visualization can be used to

facilitate the setting of policy agendas and open policy windows (Kingdon 1984) is of critical importance for public management and policy analysts alike.

Research Methodologies Another basic competency needed for any public manager using policy informatics is a foundational understanding of research methods, particularly quantitative reasoning and methodologies. A foundational understanding of data validity, analytical rigor and relevance, statistical significance, and the like are needed to be effective consumers of informatics. That said, traditional public managers should also be exposed to qualitative methods as well, refining their powers of observation, understanding how symbols, stories, and numbers are used to govern, and how data and data visualization and computer simulations play into these mental models.

Performance Management A key feature of systems thinking as applied to policy informatics is the importance of understanding how data and analysis are to be used and who the intended users of the data are (Patton 2008). The integration of policy informatics into strategic planning (Bryson 2011), performance management systems (Moynihan 2008), and ultimately woven into an organization's capacity to learn, adapt, and evolve (Argyis and Schön 1996) are critically important in this vein. As policy informatics trends evolve, public managers will likely need to be exposed to uses of decision support tools, dashboards, and other computationally driven models and visualizations to support organizational performance.

Financial Management Since the first systemic budgeting systems were put in place, public managers have been urged to use the budgeting process as a planning and evaluation tool (Willoughby 1918). This approach was formally codified in the 1960s with the planning–programming–budgeting (PPB) system with its focus on planning, managerial, and operational control (Schick 1966) and later adopted into more contemporary approaches to budgeting (Caiden 1981). Using informative projects, programs, or platforms to make strategic resource allocation decisions is a necessary given and a capacity that effective public managers must master. Likewise, the policy analyst will likely need to integrate financial resource flows and costs into their projects.

Collaborative and Cooperative Capacity Building The development and use of policy informatics projects, programs, or platforms is rarely, if ever, undertaken as an individual, isolated endeavor. It is more likely that such initiatives will require interagency, interorganizational, or intergroup coordination. It is also likely that content experts will need to be partnered with analysts and programmers to complete tasks and execute designs. The public manager and policy analyst must both possess the capacity to facilitate collaborative management functions (O'Leary and Bingham 2009).

Basic Communication Skills This perhaps goes without saying, but the heart of any informatics project lies in the ability to effectively communicate findings and ideas through the analysis of data.

Social Media, Information Technology, and e-Governance Awareness A final competency concerns public managers' capacity to deepen their understanding of how social media, Web-based tools, and related information technologies are being employed to foster various e-government, e-governance, and related initiatives (Mergel 2013). Placing policy informatics projects and programs within the context of these larger trends and uses is something that public managers must be exposed to.

Within our MPA program, we have operationalized these capacities within a four-point rubric that outlines what a student needs to do to demonstrate meeting these standards. The rubric below highlights 8 of our program's 18 capacities. All 18 of these capacities are situated under 1 of the 5 core competencies tied to the accreditation standards of the Network of Schools of Public Affairs and Administration (NASPAA), the professional accrediting association in the USA, and increasingly in other countries as well, for MPA and MPP programs. A complete list of these core competencies and the 18 capacities nested under them are provided in Appendix of this chapter.

The eight capacities that we have singled out as being the most salient to the role of policy informatics in public administration are provided in Table 2.1. The rubric follows a four-point scale, ranging from "does not meet standard," "approaches standard," "meets standard," and "exceeds standard."

2.2.2 Policy Informatics Analysts

A second type of practitioner to be considered is what we are referring to as a "policy informatics analyst." When considering the kinds of competencies that policy informatics analysts need to be successful, we first assume that the basic competencies outlined in the prior section apply here as well. In other words, effective policy informatics analysts must be systems thinkers in order to place data and their analysis into context, be cognizant of current uses of decision support systems (and related platforms) to enable organizational learning, performance, and strategic planning, and possess an awareness of e-governance and e-government initiatives and how they are transforming contemporary public management and policy planning practices. In addition, policy analysts must possess a capacity to understand policy systems: How policies are made and implemented? This baseline understanding can then be used to consider the placement, purpose, and design of policy informatics projects or programs. We lay out more specific analyst capacities below.

Advanced Research Methods of Information Technology Applications In many instances, policy informatics analysts will need to move beyond meeting the standard. This is particularly true in the area of exceeding the public manager standards for research methods and utilization of information technology. It is assumed that effective policy informatics analysts will have a strong foundation in quantitative methodologies and applications. To obtain these skills, policy analysts will need to move beyond basic surveys of research methods into more advanced research methods curriculum.

Table 2.1 Public manager policy informatics capacities

Capacity	Does not meet standard	Approaches standard	Meets standard	Exceeds standard
Capacity to apply knowledge of system dynamics and network structures in public administration practices	Does not understand the basic operations of systems and networks; cannot explain why understanding cases and contexts in terms of systems and networks is important	Can provide a basic overview of what system dynamics and network structures are and illustrate how they are evident in particular cases and contexts	Is able to undertake an analysis of a complex public administration issue, problem, or context using basic system dynamics and network frameworks	Can apply system dynamics and network frameworks to existing cases and contexts to derive working solutions or feasible alternatives to pressing administrative and policy problems
Capacity to apply policy streams, cycles, systems foci upon past, present, and future policy issues, and to understand how problem identification impacts public administration	Possesses limited capacity to utilize policy streams and policy stage heuristics model to describe observed phenomena. Can isolate simple problems from solutions, but has difficulty separating ill-structured problems from solutions	Possesses some capacity to utilize policy streams and to describe policy stage heuristics model observed phenomena. Possesses some capacity to define how problems are framed by different policy actors	Employs a policy streams or policy stage heuristics model approach to the study of observed phenomena. Can demonstrate how problem definition is defined within specific policy contexts and deconstruct the relationship between problem definitions and solutions	Employs a policy streams or policy stage heuristics model approach to the diagnosis of a problem raised in real-life policy dilemmas. Can articulate how conflicts over problem definition contribute to wicked policy problems
Capacity to employ quantitative and qualitative research methods for program evaluation and action research	Possesses a limited capacity to employ survey, interview, or other social research methods to a focus area. Can explain why it is important to undertake program or project evaluation, but possesses limited capacity to actually carrying it out	Demonstrates a capacity to employ survey, interview, or other social research methods to a focus area and an understanding of how such data and analysis are useful in administrative practice. Can provide a rationale for undertaking program/project	Can provide a piece of original analysis of an observed phenomenon employing one qualitative or quantitative methodology effectively. Possesses capacity to commission a piece of original research. Can provide a detailed account for how a	Demonstrates the capacity to undertake an independent research agenda through employing one or more social research methods around a topic of study of importance to public administration. Can demonstrate the successful execution of a program or

Table 2.1 (continued)

Capacity	Does not meet standard	Approaches standard	Meets standard	Exceeds standard
		evaluation and explain what the possible goals and outcomes of such an evaluation might be	program or project evaluation project should be structured within the context of a specific program or project	project evaluation or the successful utilization of a program or project evaluation to improve administrative practice
Capacity to apply sound performance measurement and management practices	Can provide an explanation of why performance goals and measures are important in public administration, but cannot apply this reasoning to specific contexts	Can identify the performance management considerations for a particular situation or context, but has limited capacity to evaluate the effectiveness of performance management systems	Can identify and analyze performance management systems, needs, and emerging opportunities within a specific organization or network	Can provide new insights into the performance management challenges facing an organization or network, and suggest alternative design and measurement scenarios
Capacity to apply sound financial planning and fiscal responsibility	Can identify why budgeting and sound fiscal management practices are important, but cannot analyze how and/or if such practices are being used within specific contexts	Can identify fiscal planning and budgeting practices for a particular situation or context, but has limited capacity to evaluate the effectiveness of a financial management system	Can identify and analyze financial management systems, needs, and emerging opportunities within a specific organization or network	Can provide new insights into the financial management challenges facing an organization or network, and suggest alternative design and budgeting scenarios
Capacity to achieve cooperation through participatory practices	Can explain why it is important for public administrators to be open and responsive practitioners in a vague or abstract way, but cannot provide specific explanations or justifications applied to particular contexts	Can identify instances in specific cases or contexts where a public administrator demonstrated or failed to demonstrate inclusive practices	Can demonstrate how inclusive practices and conflict management leads to cooperation for forming coalitions and collaborative practices	Can orchestrate any of the following: coalition building across units, organizations, or institutions, effective teamwork, and/or conflict management

Table 2.1 (continued)

Capacity	Does not meet standard	Approaches standard	Meets standard	Exceeds standard
Capacity to undertake high quality oral, written communication	Demonstrates some ability to express ideas verbally and in writing. Lacks consistent capacity to present and write	Possesses the capacity to write documents that are free of grammatical errors and are organized in a clear and efficient manner. Possesses the capacity to present ideas in a professional manner. Suffers from a lack of consistency in the presentation of material and expression or original ideas and concepts	Is capable of consistently expressing ideas verbally and in writing in a professional manner that communicates messages to intended audiences	Can demonstrate some instances in which verbal and written communication has persuaded others to take action
Capacity to undertake high quality electronically mediated communication and utilize information systems and media to advance objectives	Can explain why information technology is important to contemporary workplaces and public administration environments. Possesses direct experience with information technology, but little understanding for how IT informs professional practice	Can identify instances in specific cases or context where a public administrator successfully or unsuccessfully demonstrated a capacity to use IT to foster innovation, improve services, or deepen accountability. Analysis at this level is relegated to descriptions and thin analysis	Can identify how IT impacts workplaces and public policy. Can diagnose problems associated with IT tools, procedures, and uses	Demonstrates a capacity to view IT in terms of systems design. Is capable of working with IT professionals in identifying areas of need for IT upgrades, IT procedures, and IT uses in real setting

IT information technology

Competencies in advanced quantitative methods in which students learn to clean and manage large databases, perform advanced statistical tests, develop linear regression models to describe causal relationship, and the like are needed. Capacity to work across software platforms such as Excel, Statistical Package for the Social Sciences (SPSS), Analytica, and the like are important. Increasingly, the capacity to triangulate different methods, including qualitative approaches such as interviews, focus groups, participant observations is needed.

Data Visualization and Design Not only must analysts be aware of how these methods and decision support platforms may be used by practitioners but also they must know how to design and implement them. Therefore, we suggest that policy informatics analysts be exposed to design principles and how they may be applied to decision support systems, big data projects, and the like. Policy informatics analysts will need to understand and appreciate how data visualization techniques are being employed to "tell a story" through data.

Figure 2.1 provides an illustration of one student's effort to visualize campaign donations to state legislatures from the gas-extraction (fracking) industry undertaken by a masters student, Jeffery Castle for a *system analysis and strategic management* class taught by Koliba.

Castle's project demonstrates the power of data visualization to convey a central message drawing from existing databases. With a solid research methods background and exposure to visualization and design principles in class, he was able to develop an insightful policy informatics project.

Basic to Advanced Programming Language Skills Arguably, policy informatics analysts will possess a capacity to visualize and present data in a manner that is accessible. Increasingly, web-based tools are being used to design user interfaces. Knowledge of JAVA and HTML are likely most helpful in these regards. In some instances, original programs and models will need to be written through the use of programming languages such as Python, R, C++, etc. The extent to which existing software programs, be they open source or proprietary, provide enough utility to execute policy informatics projects, programs, or platforms is a continuing subject of debate within the policy informatics community. Exactly how much and to what extent specific programming languages and software programs are needing to be mastered is a standing question. For the purposes of writing this chapter, we rely on our current baseline observations and encourage more discussion and debate about the range of competencies needed by successful policy analysts.

Basic to More Advanced Modeling Skills More advanced policy informatics analysts will employ computational modeling approaches that allow for the incorporation of more complex interactions between variables. These models may be used to capture systems as dynamic, emergent, and path dependent. The outputs of these models may allow for scenario testing through simulation (Koliba et al. 2011). With the advancement of modeling software, it is becoming easier for analysts to develop system dynamics models, agent-based models, and dynamic networks designed to simulate the features of complex adaptive systems. In addition, the ability to manage and store data and link or wrap databases is often necessary.
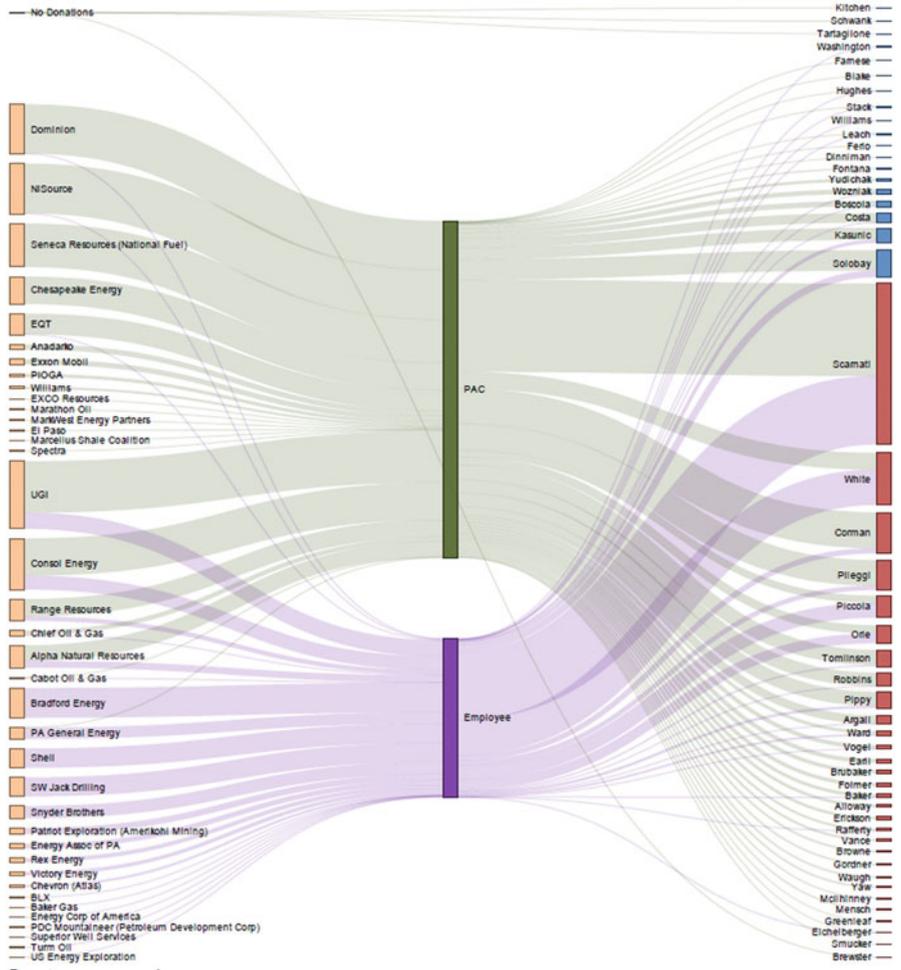
Fig. 2.1 Campaign contributions to the Pennsylvania State Senate and party membership. The goal of this analysis is to develop a visualization tool to translate publically available campaign contribution information into an easily accessible, visually appealing, and interactive format. While campaign contribution data are filed and available to the public through the Pennsylvania Department of State, it is not easily synthesized. This analysis uses a publically available database that has been published on marcellusmoney.org. In order to visualize the data, a tool was used that allows for the creation of a Sankey diagram that is able to be manipulated and interacted within an Internet browser. A Sankey diagram visualizes the magnitude of flow between the nodes of a network (Castle 2014)

The ability of analysts to draw on a diverse array of methods and theoretical frameworks to envision and create models is of critical importance. Any potential policy informatics project, program, or platform will be enabled or constrained by the modeling logic in place. With a plurality of tools at one's disposal, policy informatics analysts will be better positioned to design relevant and legitimate models.
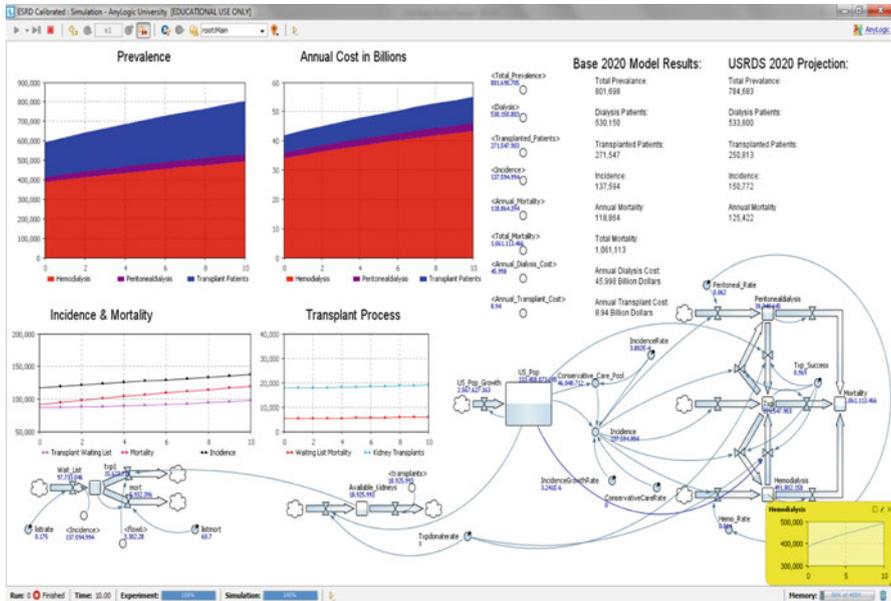
Fig. 2.2 End-stage renal disease (ESRD) system dynamics population model. To provide clinicians and health care administrators with a greater understanding of the combined costs associated with the many critical care pathways associated with ESRD, a system dynamics model was designed to simulate the total expenses of ESRD treatment for the USA, as well as incidence and mortality rates associated with different critical care pathways: kidney transplant, hemodialysis, peritoneal dialysis, and conservative care. Calibrated to US Renal Data System (USRDS) 2013 Annual and Historical Data Report and the US Census Bureau for the years 2005–2010, encompassing all ESRD patients under treatment in the USA from 2005 to 2010, the ESRD population model predicts the growth and costs of ESRD treatment type populations using historical patterns. The model has been calibrated against the output of the USRDS's own prediction for the year 2020 and also tested by running historic scenarios and comparing the output to existing data. Using a web interface designed to allow users to alter certain combinations of parameters, several scenarios are run to project future spending, incidence, and mortalities if certain combinations of critical care pathways are pursued. These scenarios include: a doubling of kidney donations and transplant rates, a marked increase in the offering of peritoneal dialysis, and an increase in conservative care routes for patients over 65. The results of these scenario runs are shared, demonstrating sizable cost savings and increased survival rates. Implications of clinical practice, public policy, and further research are drawn (Fernandez 2013)

Figure 2.2 provides an illustration of Luca Fernandez's system dynamics model of critical care pathways for end-stage renal disease (ESRD). Fernandez took Koliba's *system analysis and strategic management* course and Zia's *decision-making modeling* course. This model, constructed using the proprietary software, AnyLogic, was initially constructed as a project in Zia's course.

Castle and Fernandez's projects illustrate how master's-level students with an eye toward becoming policy informatics analysts can build skills and capacities to develop useful informatics projects that can guide policy and public management. They were guided to this point by taking advanced courses designed explicitly with policy informatics outcomes in mind.