

New Hope for Policy Schools

Examining Systems Thinking Solutions to Improve Policy Education

Wa'ad Aljarri^b, Jenifer Bustamante^a, Amber Ingwell^a, Tierra Labrada^a, B.J. Nadig^a, Janet Shin^a, Margaret Weis^a, Laura Cabrera^{a,c}, and Derek Cabrera^{a,c,@}

a: Jeb E Brooks School of Public Policy, Cornell University, Ithaca, NY 14850, USA

b: Cornell University College of Veterinary Medicine, Ithaca, NY 14850

c: Cabrera Research Lab., Ithaca, NY 14850 USA

@: dac66@cornell.edu

ABSTRACT: This report explores the potential of systems thinking as a transformative educational tool for policymakers. Our study conducted an investigation into the effectiveness of the Distinctions Systems Relationships Perspectives (DSRP) model in enhancing the comprehension and application of systems thinking among a sample representative of the U.S. population. The quasi-experimental design utilized a short training video to introduce participants to the DSRP methodology within a survey to measure changes in their response to a realistic policy problem scenario. Results were highly statistically significant and indicated a 200-500% improvement in participants' ability to apply systems thinking concepts after the intervention and resulted in better problem-solving ability overall. This suggests that systems thinking education, particularly through the DSRP model, could significantly enhance policy formulation and decision-making processes. We situated our study within a Systems Literature Review on systems thinking, policy education, and complex decision making. Our review revealed a dearth of empirically-backed approaches to policy development and decision making while DSRP is the strongest theory of systems thinking with concrete evidence. Overall, our research findings advocate for the integration of systems thinking into policy education curricula to better equip future policymakers to tackle complex societal issues.

KEYWORDS: public policy education | wicked problems | complex decision making | educational intervention | policy curriculum | problem solving | systems thinking

Introduction

How to solve the most pressing global problems dominates debate in the 21st century as we face some of the most existential struggles of our species [1], [2]. The demands of a growing population and globalized economy exacerbate climate change, increase prevalence of pandemics, and highlight the fragility of democratic norms in governance. Conceived in 1973 by Rittel and Webber [3], “wicked problems” are ill-defined issues with no single obvious solution or set of solutions due to their overlapping nature across systems. Essentially, all policy problems are wicked problems because of the myriad perspectives on how to define and isolate the issue at hand. This holds true across scale, whether a local municipality trying to

create an equitable education system or a cohort of nations attempting to curb the cascading effects of global carbon emissions. Systems thinking reveals that the challenge of wicked problems stems not from their complexity but the misalignment between our mental models and reality [4].

We live in a volatile, unpredictable, complex, and ambiguous (VUCA) world made up of interconnected and overlaid complex adaptive systems (CASs) composed of agents following simple rules that lead to emergent complexity [4], [5], [6]. Our VUCA reality is itself a large CAS, full of actions and reactions that produce the world around us. Yet humans tend to think in a manner characterized by Derek and Laura Cabrera [4] as linear, anthropocentric, mechanistic, and ordered (LAMO). We further structure our thinking into mental models to organize information from the world around us to create meaning [7]. Taken together, our LAMO thinking leads us to inhabit mental models fundamentally misaligned with our VUCA reality [2].

Wicked problems are thus not the result of their complexity alone but also a symptom of our failure to properly conceive the simplicity underlying said complexity. Research by Steinhall et al. [2] demonstrated that individuals fail to see the webbed causality of complex problems, occluding the webbed solutions necessary to effectively combat the problems. Our failure to understand the wholeness of the system produces partial solutions doomed to only reduce the issue at best or fail completely at worst—never eliminate it entirely. Improving our metacognition, or the ability to address our own thinking, could shift our perception of wicked problems and support the development of webbed solutions desperately needed.

Nowhere is this shift more important than the field of policy development. Societies task politicians, planners, and government administrators to develop and implement the policy solutions meant to address the most pressing problems. Wen et al. [8] revealed that policymakers lack empirically-tested methods of policy development, many individuals relying on intuition alone. Of those using specific frameworks, most cited the Strengths, Opportunities, Weaknesses, and Threats (SWOT) approach or a Cost-Benefit Analysis (CBA) as their method of choice. Those holding a graduate education cited the greatest use of these frameworks despite the dearth of evidence supporting their efficacy. Policymakers appear to learn this reliance on the frameworks in their professional education and then employ the methods in their consequential careers. Why do policy schools continue to arm individuals with these unsubstantiated frameworks rooted in faulty mental models when an empirically-proven method of systems thinking exists that better captures the complex reality of wicked problems?

Our research aims to bridge theory and practice. The Distinctions, Systems, Relationships, and Perspectives (DSRP) theory of systems thinking is an evidence-based approach that has shown promise in numerous scientific studies as a method to understand and address complex problems [7], [9], [10]. Yet researchers still lack a core understanding of whether we can shift the thinking of others in practice and via what methods. We therefore embarked in this study to empirically investigate if an educational intervention could nudge someone's thinking towards a more systemic approach around a complex problem. To do so, we first placed our research within the current state of knowledge on systems thinking, policy education, and complex decision-making via a Systems Literature Review [11]. We then developed and deployed a quasi-experimental design with a survey to test the effect of five short trainings on scientifically-proven DSRP tools within a sample representative of the U.S. population. Our results show, with high statistical significance, a 200-500% increase in exhibiting systems thinking after interventions

across the board and an increase in overall problem solving. These promising results should inspire an improvement in both policy education and our general approach to human thinking to support the development of individuals more equipped to address the existential wicked problems we face today.

Systems Literature Review of Systems Thinking, Policy Education and Complex Decision Making

Our literature review aimed to understand to what degree people generally and policymakers specifically think systemically. Additionally, we sought to learn what research currently says about how people think and make difficult decisions, especially around complex ideas with conflicting perspectives. Lastly, we wanted to examine what is known about how we educate individuals to improve or shift their thinking and problem solving both generally and within the graduate policy programs. Overall, our goal was to determine if the methods and thinking styles presently employed by decision-makers adequately meet the complexity of systemic wicked problems. Informed by Boote and Beile [12], Cabrera et al. [11], and the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) [13], [14], we began with a hasty description on the state of systems thinking followed by a robust Systems Literature Review.

Systems Thinking

Our contemporary world is characterized by its complexity, rapid pace, and an abundance of information. Within this context, problem solving becomes increasingly intricate. However, the crux of the challenge often lies not in the complexity itself, but rather in the disparity between our mental models of how systems operate and their actual functioning in the real world [15]. While systems thinking offers a pathway to uncovering the fundamental structures of systems and cognition, the field is varied with numerous iterations of interpretation and a long legacy of untested theory. The proliferation of methodological innovations served to diversify the knowledge base of systems thinking but at same time complicated implementation due to the multitude of approaches. DSRP emerged in response to the preceding “waves” (i.e., paradigms) of systems thinking approaches and serves as a quantifiable basis for differentiating types of mental models [16].

DSRP has more empirical evidence than any other systems thinking theory currently in circulation [7], [10], [17], [18], [19], [20]. The identification of four key cognitive skills—making distinctions (D), organizing part-whole systems (S), recognizing relationships (R), and taking perspectives (P)—which underpin all systems thinking frameworks revolutionized the field [7]. These skills illuminate the underlying patterns of our thought processes, exposing the pitfalls that beset many of our societal systems [7]. Now over two decades old, DSRP has amassed considerable empirical evidence supporting its validity. Yet, it remains frequently misunderstood. The theory’s four fundamental patterns are further delineated by their underlying elements: distinctions (D) of identity (i) and other (o), systems (S) composed of parts (p) and wholes (w), relationships (R) involving action (a) and reaction (r), and perspectives (P) encompassing point (p) and view (v) [7]. These patterns are universal across both cognitive and material complexity, providing a framework for understanding both natural occurring systems as well as cognitive complexity.

Alongside the core principles of DSRP is the notion of complex adaptive systems (CAS), which has been explored in a wide range of disciplines like social sciences and mathematics [8]. A CAS consists of autonomous agents, the simple rules that these agents perform daily, and the collective dynamics that emerge from following these rules [6]. The ensuing knowledge produced from analyzing the disparate parts of the system and the confluence of interactions is invaluable for inciting revolutionary change. However, one can only begin to understand a CAS upon understanding the agents' mental models and the system with which these agents interact [9]. The foundational principles of DSRP are integral to how we conceptualize and organize information to derive meaning. By consciously applying these rules, we gain insight into our cognitive processes, engaging in metacognition, or "thinking about thinking" [15]. Metacognition is crucial for ensuring that we approach perspectives deliberately without inadvertently neglecting crucial viewpoints [15]. Moreover, the application of DSRP prompts us to challenge entrenched mental models that shape our worldview, fostering a more critical understanding of accepted ideas and perspectives. Given the simplicity and universality of these rules, DSRP holds relevance for individuals across diverse backgrounds and disciplines.

While a growing body of research advocates for systems thinking education, questions persist regarding the efficacy of educational strategies [15]. The emergence of DSRP as a universal cognitive structure offers promise for developing more feasible assessment tools. For example, Derek Cabrera coined the term "cognitive jig" to highlight the practical and tactile nature of common mental model structures. Originated from the concept of physical jigs used in carpentry to streamline repetitive tasks, these jigs were conceptual templates that enhanced cognitive efficiency by offering reusable structures of knowledge and thinking. The cognitive jigs were akin to physical jigs in their ability to save time and effort. In 2021, Cabrera replaced the term cognitive jigs with cognitive "moves" to emphasize their dynamic and adaptable nature [21]. Much like physical exercises practiced to improve performance, individuals can hone moves through repetition to easily identify common patterns of thought. Research conducted by Cabrera Lab revealed the Pareto principle that 20% of causes often drives 80% of outcomes held in moves, indicating that focusing on a select few moves, such as the Is/Is Not Move or the Zoom in/Zoom Out Move, yields the most significant cognitive benefits [21]. These moves are characterized by being content-agnostic, molecular, and common structures, facilitating their widespread applicability across various domains of thinking.

Coverage of the Literature

Observations from the hasty systems thinking review revealed that much of the existing literature predominantly discusses the development of new theoretical models and their application through case studies with a significant portion lacking empirical validation. We conducted extensive searches aimed at uncovering how current educational methodologies and policy development addresses or ignores systems thinking to enhance solution formulation. The overarching goal of this review was to understand how systems thinking is conceptualized and taught within the context of policy education, and whether there is a consensus on its effectiveness in crafting and implementing policy solutions. We found that while systems thinking is widely recognized as a beneficial approach, it often operates more as an implicit, common-sense tool rather than as a deliberately applied methodology. Despite its broad endorsement, there lacks a standardized framework that can be consistently applied across contexts to effectively tackle both simple and complex policy challenges.

Selection Process and Results by Search Term

We followed the Systems Literature Review process [11] to ensure a systematic and comprehensive review of scholarly articles. Designated researchers conducted searches using the Cornell University Library database using specific search terms designed to ensure a broad and diverse range of sources. Search terms and the subsequent refinement of results aligned with the central objectives of our research—to investigate the interconnections between policy outcomes, decision-making processes, and approaches to problem solving within complex and controversial contexts. For example, our reviewers chose terms such as "Learning AND Policy" and "Decision-Making AND Process" to delve into the influence of educational insights and decision-making frameworks on policy formulation and implementation. We found the adjective “decision-making” rather than the compound noun “decision making” brought more relevant results. The “AND” allowed the database to return papers addressing both words in the search without overly narrowing results. Reviewers made strategic cuts to maintain focus such as excluding the combinations of “Education” with “Decision-Making” or “Policy” due to a predominance of those results discussing general dynamics within educational institutions rather than the educational process itself. Similarly, terms that yielded results too niche or overly medical in nature were excluded, as they did not directly contribute to our core themes of policy impact and decision making.

We initially selected the top 30 titles sorted by relevance according to the database and published in English available in full text from peer-reviewed academic journals within the past five years. This selection process excluded non-peer-reviewed articles, outdated studies, and off-topic content. The filtering process involved a first review by title alone, then abstract, and finally a full-text review to ensure we read a sample of only the most relevant studies. Our inclusion criteria focused on the policy rather than on politics. For example, articles on politics remained in review only if the paper’s goal was to elucidate the impact of politics on policy itself. This guided the selection of articles towards one that discussed the influence of political discourse on policy-making rather than those solely exploring political dynamics. Our criteria also emphasized the inclusion of articles that provided insights into broader academic and societal frameworks or offered international perspectives, so long as these perspectives were pertinent to the broader context of our study. Further, we prioritized articles that shed light on the cognitive processes supporting policy-related decision making, thus valuing contributions exploring how individuals and institutions navigate complex problems.

Scholarly Search Results by Term																		
Database Cornell University Library							Filters Available, Full Text, Peer-Reviewed, Past 5 years, Academic Journals, English, Sorted by relevancy											
	Learning AND Policy	Learning AND Decision-Making	Thinking AND Policy	Thinking AND Issue	Complex AND Policy	Decision-Making Process AND Policy	Controversial AND Issue	Controversial AND Policy	Controversial AND Decision-Making	Divisive AND Issue	Divisive AND Policy	Divisive AND Decision-Making	Problem Solving	Problem Solving AND Complex	Problem Solving AND Divisive	Public Policy Education	Public Policy AND Curriculum	
Search Term																		
Total Items Returned	997,590	676,531	515,812	855,886	1,261,997	118,997	1,533,621	636,557	2,845,452	28,884	21,956	2,845,445	347,827	179,386	1,653	251	21,364	
Top 30 Articles	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	
Articles with Relevant Titles	13	13	17	19	16	19	15	14	25	17	17	24	21	24	21	22	15	
Articles with Relevant Abstracts	9	9	10	9	9	10	10	9	18	9	11	11	9	11	9	11	7	
Final after Full Text Review	6	4	6	9	8	6	6	7	12	6	10	6	5	8	9	9	6	

Table 1: Scholarly Search Results Returned and Selected

Table 1 illustrates the winnowing process, showing the number of studies selected across each step down to the final amount of selected articles per search term. The team strategically distributed tasks amongst researchers with regular review of one another's work to reduce individual biases and enhance the efficiency and analytical depth of our study. This collaborative approach ensured a thorough examination of the large volume of data, leading to precise and relevant academic insights. In total, the process narrowed the initial 510 articles from the top 30 returned across all 17 search terms down to the 123 most relevant papers that we reviewed in depth for our analysis.

Public Search

Our team implemented a Popular PRISMA search strategy to assess what the general public knew or what was commonly available related to the chosen search terms. Our public search compiled the top 10 web results and popular books for each search term via Google and discarded Wikipedia articles, dictionaries, and thesauruses to focus on public interpretation rather than rote definitions. After removing search terms that fetched only irrelevant websites, we narrowed the reviewed terms for the public search to six word pairings that delivered the most topical results: "Thinking AND Policy," "Complex AND Policy," "Decision-Making AND Policy," "Divisive AND Policy," "Divisive AND Decision-Making," and "Problem Solving AND Complex." We then followed the same selection criteria outlined for the scholarly search to focus on results related to systems thinking, policy education, and decision making. Table 2 shows the number of webpages and books reviewed with full titles found in Appendix B.

Public Search Results by Term						
Search Term	Thinking AND Policy	Complex AND Policy	Decision-Making AND Policy	Divisive AND Policy	Divisive AND Decision-Making	Problem Solving AND Complex
Total Webpages Results Returned	1,520,000,000	2,660,000,000	911,000,000	50,200,000	3,720,000	196,000,000
Webpages Selected from Top 10 Results	8	10	10	9	7	10
Total Book Results Returned	17,900,000	21,700,000	24,600,000	711,000	180,000	4,200,000
Books Selected from Top 10 Results	6	7	7	2	3	9

Table 2: Public Search Results Returned and Selected

The majority of reviewed results focused on policy making, decision making, and thinking. Many web pages made distinctions between terms or offered a more robust definition of the term as it applies to a particular topic area or issue. The book results overwhelmingly focused on areas of governmental policy with a strong emphasis on foreign policy decisions and general decision making. Only a few books addressed areas of personal development related to becoming a better thinker or problem solver.

Public Policy Curriculum Search

To better understand the current status of policy education as it relates to decision making, systems thinking, complexity, or strategic choices, we initiated a search of core curriculum at the 10 best policy schools in the United States. The 2023 US News and World Report [22] included universities for their Master of Public Administration (MPA) and/or Master of Public Policy (MPP) Degree programs. The

universities were ranked as follows, starting with the top program: Indiana University at Bloomington (MPA Degree), Syracuse University (MPA Degree), Harvard University (MPP Degree), University of California at Berkeley (MPA Degree), University of California at Berkeley (MPP Degree), University of Michigan at Ann Arbor (MPP Degree), University of Michigan at Ann Arbor (MPA Degree), University of Southern California (MPP Degree), University of Georgia (MPA Degree), University of Chicago (MPP Degree), University of Washington (MPA Degree), and American University (MPA Degree).

The length and intensity of the MPA and MPP programs differ as do the curriculum and fieldwork requirements. Our analysis included a hasty search of course titles and did not include course descriptions or syllabi. When comparing core curriculum course titles, we found that six of the degree programs included systems, systems thinking, decision making, complexity, or strategic choices. Of those six degree programs, only two required courses in these areas.

Synthesis of Scholarly Literature

The Systemic Literature Review illustrated various challenges facing policy education and decision-making processes, emphasizing the need for multidisciplinary approaches [23], responsible integration of technology [24], and deepened understanding of complex systems [25]. Policy actors in particular and people in general often isolate themselves in echo chambers [26], hindering the development and application of technology and solutions to complex problems [27]. Biases play a significant role in shaping decision making and learning ability and personal biases influence decision-making processes, thus impacting the effectiveness of solutions [28], [29], [30]. Further, the influence of social identities on attitudes towards policies [31], [32], particularly concerning divisive issues like climate change [33], underscores the importance of considering multiple perspectives [34]. Effective problem solving requires a comprehensive and systematic understanding of the problem rather than a simple creation of solutions [35], [36], [37].

Authors propose frameworks like gamification and systems thinking to enhance policy design and stakeholder engagement [36], [37], [38], [39], [40], integrating sustainability goals and social innovation [41]. The literature purports that understanding complex issues requires systems thinking [42], scenario-based learning [39], and critical analysis skills [43]. Effective navigation of complex policy environments and integrated learning requires multidisciplinary and innovative approaches [35]. Various models and approaches, such as Design Thinking [41] and simulation-based problem solving [44], [45], are utilized to enhance Complex Problem Solving (CPS) skills among students, with an emphasis on adaptability and metacognitive abilities [43], [46], [47].

Scholars advocate for holistic, adaptive strategies to address wicked problems [48], citing a need for interdisciplinary perspectives and the integration of economics and social work into policy education [36], [49], [50], [51]. They call for public policy education—and education in general—to adopt systemic teaching, project-based learning, and training in ethical theory to produce critical thinkers capable of addressing complex challenges [52], [53], [54], [55], [56]. The literature overwhelmingly supports the adoption of innovative approaches to problem solving that include critical thinking, multi-perspectival methods, and systems thinking to tackle the most important issues facing society today [57], [58].

Synthesis of Scholarly Methods

To analyze the methodological approach amongst researchers, we sorted each study by the scientific method utilized. The “Conceptual” category included critical thinking analyses without measurable evidence, opinion pieces, and new theories yet to be empirically tested. Our “Observational” category consisted of document analysis and studies that gathered data without direct interventions (e.g., interviews, focus groups, general surveys, etc.). “Mixed Methods” represented studies employing multiple methods. Other labels followed standard methodology definition. These categories do not reflect a hierarchy of scientific importance, as all methods are useful if they fit the research needs and level of knowledge. Figure 1 shows the results of the categorization.

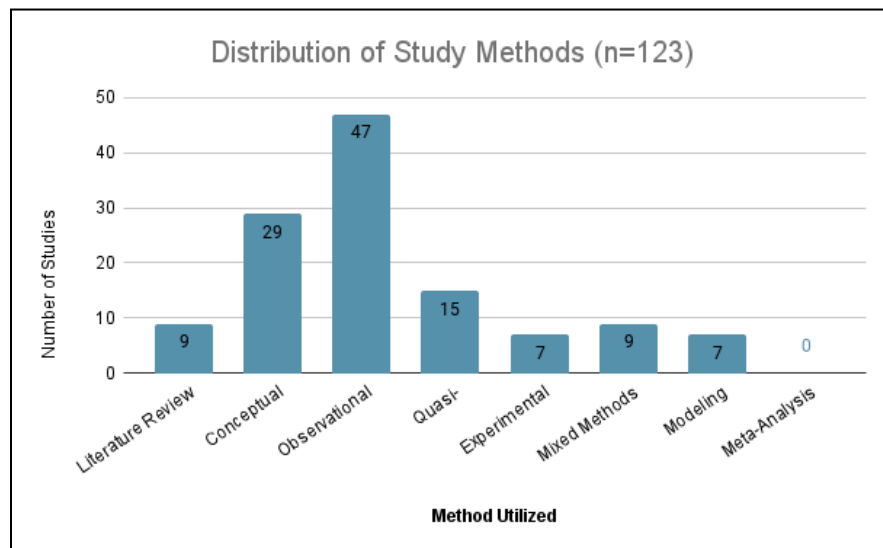


Figure 1: Methods of Selected Scholarly Literature

Of the 123 scholarly articles reviewed, a plurality were “Observational” at 47 papers, or roughly 40%. The next most common method was “Conceptual” with 29 studies, about 25% of the total examined. 15 researchers employed a quasi-experimental design, while seven used randomization (i.e., “Experimental”) to test an intervention. Nine studies employed mixed methods, or 7.3%, some of which included randomized experiments. Seven studies—mostly those investigating decision optimization—developed and tested new computer or equational modeling. Out of all articles reviewed, none were meta-analyses. Overall, the methodology distribution reflected a nascent level of knowledge on how humans are taught to transform their thinking or make decisions. Few researchers focused on intervention experimentation to directly test theories.

Next, we categorized each study based on whether or not researchers supported claims with statistically significant empirical evidence. Papers labeled “no” range from theoretical and opinion pieces to experimental studies lacking statistical substance. To qualify as a “yes,” studies needed to include a data analysis that specified reliability of results (i.e., p-values, chi-squared, robustness tests, etc.). Figure 2 displays the count across reviewed papers.

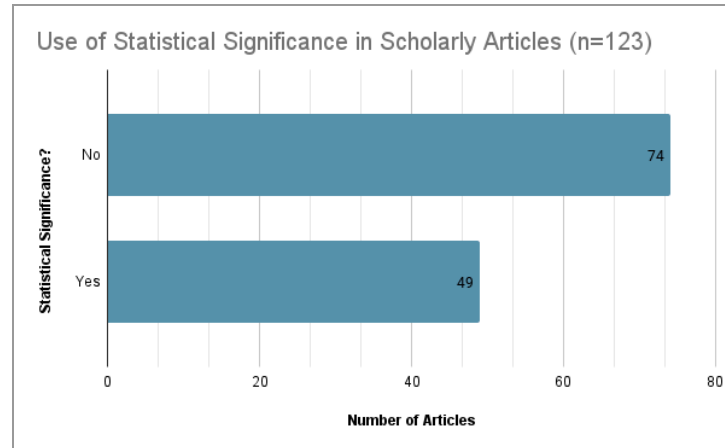


Figure 2: Statistical Significance within Selected Scholarly Literature

Studies without any specified statistical significance outnumbered those with significance by 151% at 74 to 49 articles. This lack of empirical support in decision-making and policy research poses a gap in ensuring policy solutions for wicked problems are rooted in scientifically-backed understanding of reality.

Synthesis of Scholarly Disciplines

To analyze which academic fields address thinking and policy-development, we counted discipline prevalence according to the subject matter of the journal in which an article was published. For instance, a journal on public health education fell under “education” rather than “public health” as the core purpose of the article in this case was to disseminate knowledge on educational strategy rather than studying or debating science within public health itself. Figure 3 illustrates the results of this categorization.

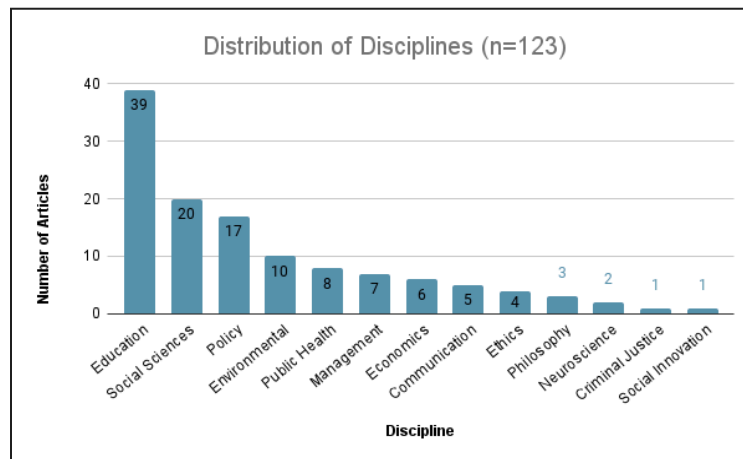


Figure 3: Academic Discipline of Scholarly Studies

Research traversed a broad spectrum of disciplines, ranging from social sciences to criminal justice and social innovation. Unsurprisingly, a majority of articles fell under education at 31.7%. Social sciences occupied 16.3% and policy held 13.8% as the second and third most common disciplines respectively.

Analyzing across our categorization methods revealed trends within a given discipline. For instance, Figure 4 illustrated how policy articles more commonly purported conclusions without statistical

significance whilst other disciplines like education had stronger empirical support. This observation aligns with claims in [2] that the oversaturation of theoretical and opinion-based research in the policy domain questions the validity of common policy development frameworks.

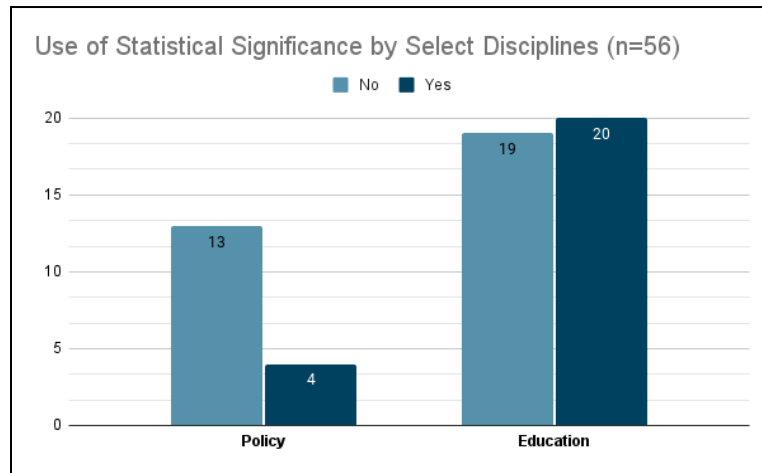


Figure 4: Use of Statistical Significance in Policy and Education Scholarship

Synthesis of Research Themes

A final categorization according to four overarching research themes finished our literature review. The “issue analysis” category included analysis of a singular topic, issue, or methodology that was often hyperspecific, complicating extrapolation of the article’s findings to other domains. This category encompassed 49% of reviewed publications. The “strategy design” category referred to studies aimed at the promotion, introduction, or implementation of a particular framework, model, or tool—often without the presence of empirical evidence. This accounted for about 30% of analyzed articles. The “history and background” category accounted for articles that solely presented literature reviews or topic overviews, which were about 12% of articles. Lastly, the “systems thinking” category held any research referencing the core tenets of the iteration of systems thinking uplifted in our research, DSRP, whether or not alluded to directly by name. This category notably encompassed the smallest fraction at only about 9% of articles. Figure 5 presents the full count of this particular analysis.

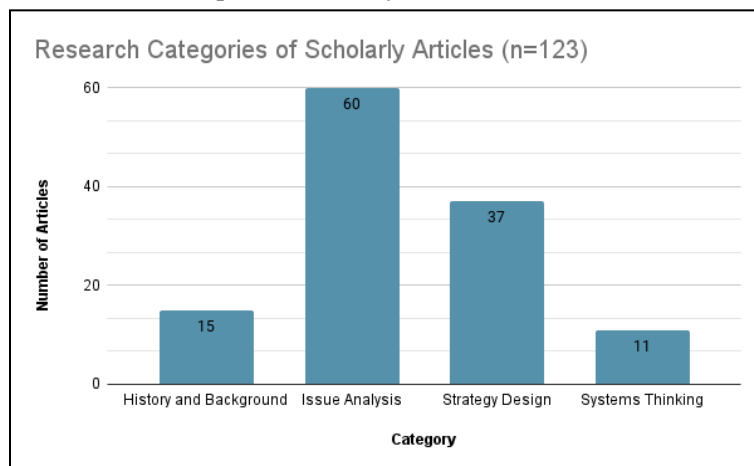


Figure 5: Distribution of Scholarly Articles by Style Category

Conclusions from Systemic Literature Review

Our comprehensive literature review delved into the realm of systems thinking, policy education, and decision-making processes, aiming to discern the efficacy of current methodologies in addressing complex, systemic issues. The results of a hasty review of systems thinking scholarship reveal that systems thinking is a crucial approach in navigating the complexities of the contemporary world, offering a pathway to understanding the fundamental structures of systems and cognition. DSRP Theory stands out for its empirical evidence and universal applicability in uncovering cognitive patterns and fostering critical thinking. Our syntheses of an extensive analysis of scholarly articles highlights that despite a growing recognition of the importance of systems thinking in policy education, a predominant reliance on conceptual models persists over empirically validated methodologies. This highlights a gap in empirically supported approaches to teaching and decision-making processes, justifying the need for more rigorous experimentation and data-driven insights. The public search results and public policy curriculum review demonstrate this same gap in both general population understanding and policymakers specifically.

In essence, our literature review elucidates the pressing need for a more systematic and evidence-based approach to policy education and decision making, grounded in the principles of systems thinking. By integrating empirical research, interdisciplinary perspectives, and rigorous experimentation, we can better equip decision-makers to tackle the complexities of systemic wicked problems.

Study Design

Given the conclusions drawn regarding the lack of empirical research, our study employed a mixed-methods approach within a quasi-experimental design to investigate the impact of a targeted video intervention on systemic thinking. Due to the absence of more robust randomized experimentations as highlighted in our literature review, a quasi-experimental design allowed for initial empirical results that can serve as foundation for future research. The primary objective was to assess changes in participants' ability to analyze complex issues through a systems thinking lens.

Utilizing an online survey, participants initially thought through a hypothetical policy scenario then experienced a brief educational intervention on one of the systems thinking “moves” identified in previous research by Derek and Laura Cabrera. Participants then returned to the same policy scenario. The study aimed to measure the effectiveness of a designated move in enhancing participants' systems thinking capabilities. Additionally, the survey asked self-perception questions to gain deeper insights into participants' proficiency in applying a systematic approach to problem solving.

Participants

After receiving approval from Cornell University's Institutional Review Board for Human Participation Research (IRB), we recruited 1000 participants via the online survey platform Cloud Research. Each participant completed one of five surveys, collectively representing a statistically significant sample of the United States population aged 18-75, as per the latest census data. Prior to participation, all individuals provided informed consent, and we took measures to anonymize the data to ensure confidentiality. Leveraging the online survey platform enabled us to efficiently and anonymously gather data, resulting in

scalable outcomes. After removing individuals with unfinished surveys, our final participant count was 988 with each provided observations before and after our educational intervention for a total of 1,976 observations. Figure 6 denotes the breakdown of these totals by survey (with more details on the moves utilized described further in this paper).

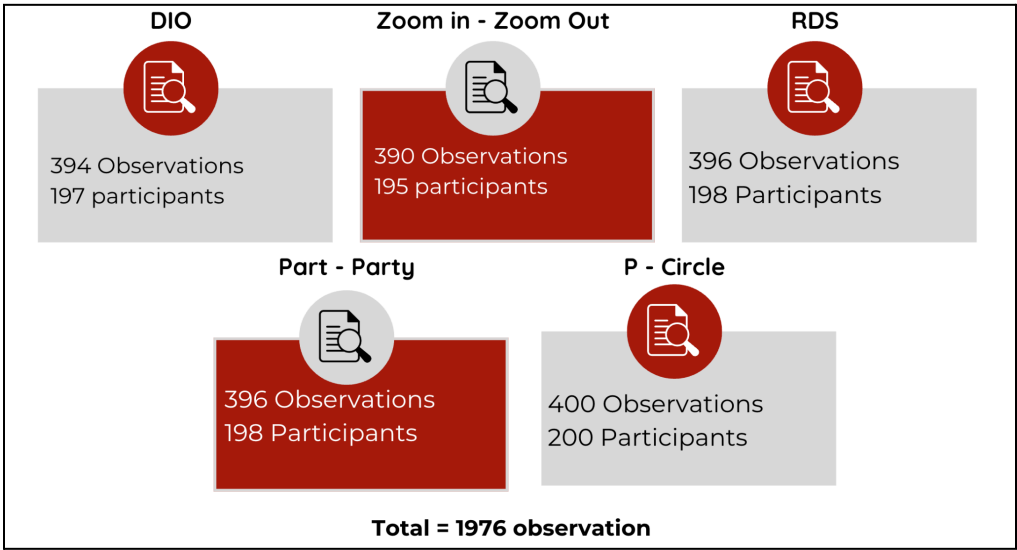


Figure 6: Number of Participants per Survey

We intentionally targeted the general population rather than focusing on policymakers for two reasons. First, the moves held potential for applicability across domains and demographics. Second, previous research on systems thinking led us to hypothesize that anyone could enhance their cognitive processes around policy issues when given the tools to do so. Our results hold direct value for policy education as advanced policy degree programs are designed to transform any general individual into one specializing in policy making. Therefore, our educational methods must work for all populations.

Survey Procedure

We designed our survey to test the impact of targeted video interventions on participants' systems thinking and problem-solving skills in addressing a fictional yet realistic policy problem. By incorporating pre- and post-video assessments (as visualized in Figure 7), we could measure the intervention's impact on participants' understanding and application of systems thinking principles. Additionally, the survey allowed us to demonstrate the natural existence of the mental model structures captured in DSRP moves before any prompting by the video intervention. Short answers facilitated a quick expression of thoughts with flexibility for creativity.

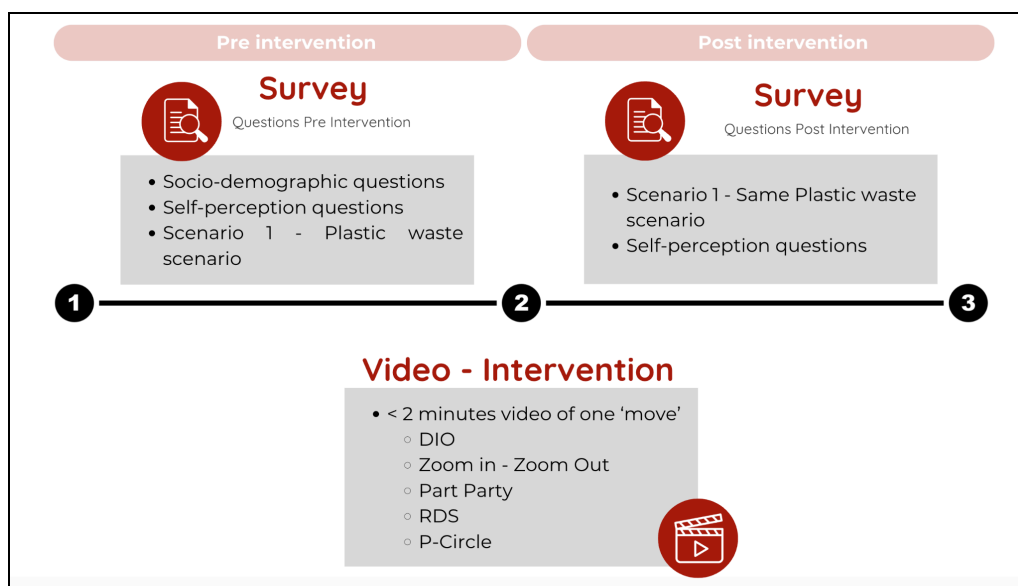


Figure 7: Survey Procedure Timeline

Scenario Selection

After considering many scenarios, we selected one on plastic waste accumulation for its broad consensus and familiarity as a public issue. As a concerning issue that resonates across diverse demographics and ideological spectrums, the plastic waste scenario reduced political perspectives interfering with the study's primary focus on the application of systems thinking. Topics like climate change or healthcare policy possess polarizing political perspectives that might have clouded our study's ability to deduce clear preliminary results on the efficacy of the educational interventions. The final scenario wording read:

In a small town, there's a growing problem - too much plastic waste is piling up. The town's leaders can't agree on a good plan to deal with it. They want you to look into the problem, summarize it, and suggest some practical ways to fix it.

The plastic waste scenario ensured participants from various backgrounds could engage with the scenario without encountering ideological barriers. This approach created an inclusive research environment conducive to comprehensive data collection and analysis, while also aligning with our commitment to studying topics of broad societal importance.

Pre-Video Assessment

Participants initially encountered the scenario before watching our video treatment. The scenario followed with a series of questions in which participants assessed their understanding of the issue, self-rated their problem-solving abilities, expressed any prior interest in plastic waste management, and articulated their confidence in assessing the town's concerns related to plastic waste. The main question of study then required participants to provide a concise qualitative description outlining their approach to addressing the problem outlined in the scenery and suggesting solutions.

Video Treatment and Move Selection

In each of the five surveys, participants underwent training through distinct video treatments focusing on one of five selected systems thinking moves. Despite variations in content, all videos shared a consistent structure, narration style, and length. They explained key elements of the respective move and illustrated its application through examples. These moves offer a universally applicable framework for exercising the core aspects of systems thinking.

The examined moves came from the results of the previous research into the Pareto law's application in systems thinking as studied by the Cabrera Research Lab [59]. In a study with over 35,000 participants, practicing just five of the 47 designated moves successfully captured the basic structures of DSRP and allowed efficient application. These five empirically-studied fundamental moves are "Is/Is Not," "Zoom In/Zoom Out," "Part Party," "RDS Barbell," and "P-Circle." The Is/Is Not move involves precisely defining something by outlining what it is and what it is not, offering clarity through contrast. The Zoom In/Zoom Out move entails examining the parts that make up an object or idea of interest (i.e., "zooming in") or examining a broader system in which that idea or system rests (i.e., "zooming out"), ensuring a comprehensive understanding across scales. With the Part Party move, one dissects a problem into its constituent parts and explores the relationships between identified parts, facilitating a holistic comprehension. Employing the RDS Barbell move involves identifying relationships between two distinct ideas or objects, aiming to grasp the interconnectedness of diverse components within a unified system. Finally, the P-Circle move incorporates various viewpoints on a singular concept or object, fostering a more complete interpretation of reality with multiple simultaneous perspectives.

Our study examined each of these five moves with one exception. The Is/Is Not move at its most basic is only the distinguishing of an identity and an other. For a broader application to policy analysis, we studied the "Dio List" move (pronounced "D-I-O") which builds on Is/Is Not by listing additional components (i.e., parts) that make up what something "is" or "is not." Overall, while each tested move individually does not offer a comprehensive understanding of DSRP, collectively they serve as a valuable lens through which to assess and analyze complex problems. Examining each move through a unique survey enabled us to determine which moves most easily resonate with a quick intervention and which may need more research to find translational strategies for learning. Appendix D provides full transcripts and images from each video treatment.

Post-Video Assessment

After the video intervention, the survey prompted participants to revisit the plastic waste scenario and offer a short-answer qualitative description of their approach to assessing the problem but now by exercising the move taught in the video. Participants reassessed their confidence in their ability to address the problem. They additionally self-reported whether they felt their analysis of the problem in the scenario was stronger before or after watching the video problem and then indicated the likelihood of applying the thinking tool in other life situations.

Variable Measures and Summary Statistics

This section provides an overview of the variables and measures used in the study to analyze the data collected from participants. Descriptive statistics summarize and describe the characteristics of the data, helping to understand central tendencies, variability, and distribution.

Participant Demographics

We gathered basic demographic information from survey participants to analyze their effect as control or confounding variables. These included a variety of gender options (e.g., male, female, other, etc.), age measured in categorical ranges (e.g., 18 to 24, 25 to 34, 45 to 54, etc.), race and ethnicity options aligned with the U.S. Census, level of education, and political stance ranging from extremely conservative to extremely liberal. Summary statistics of this information is in Table 3. Not every respondent offered an answer to each question; we include the numbers for all information obtained in our tables.

Total Observations		988	
<u>Variable</u>	<u>Number Obs.</u>	<u>Percent</u>	
Age	988		
18 to 24	76	7.69	
25 to 34	234	23.68	
35 to 44	171	17.31	
45 to 54	206	20.85	
55 to 64	149	15.08	
65 to 74	136	13.77	
75 or older	16	1.62	
Level of Education	977		
Advanced Degree (Master's, Ph.D., M.D.)	153	15.66	
Associate degree	107	10.95	
Bachelor's degree	421	43.09	
Graduated high school	107	10.95	
Some college, no degree	77	7.88	
Trade/technical school	112	11.46	
Gender	985		
Male	495	50.25	
Female	490	49.75	
Race/ Ethnicity	988		
White	640	64.78	
Hispanic/Latino	64	6.48	
Black/African American	120	12.15	
Asian	45	4.55	
Multiple/Other	119	12.04	
Political Stance	980		
Conservative	156	15.92	
Extremely Conservative	64	6.53	

Liberal	368	37.55
Extremely Liberal	117	11.94
Moderate	275	28.06

Table 3. Summary Statistics of Sample Demographics

Considering our narrowing to participants ages 18-75, our sample reflected an age distribution similar to the most recent U.S. Census. Only 7.69% were under 24 while the majority of participants were between the ages of 25-54 at 61.84% total. Of the remaining categorical ranges, 15.08% of participants were 55-64, 13.77% were 65 to 74, and 1.62% selected 75 or older. From the 977 participants that gave education level, 15.66% held advanced degrees, 43.09% had a bachelor's degree, and 10.95% had an associate's degree. Of the remaining, 11.46% went to trade/technical school, 7.88% had attended some college without a degree, and 10.95% had only a high school education. Despite offering a broad range of gender options, the 985 that gave their gender all selected either male (50.25%) or female (49.75%). Similarly, while offering the option to select multiple races and ethnicities, most chose one category. Due to small numbers in some categories (i.e., American Indian and Pacific Islander), we sorted individuals into the following groups for stronger data analysis: White (64.78%), Hispanic/Latino (6.48%), Black/African American (12.15%), Asian (4.55%), and Multiple/Other (12.04%). A plurality of respondents were liberal or moderate at 37.55% and 28.06% respectively. Of the extremes, 11.64% identified as extremely liberal and 6.53% as extremely conservative. The last 15.92% were conservative.

Pre-Treatment Self Perception

Before treatment, questions gauged participants' reactions to the presented scenario and their self-perceived problem-solving skills. They then indicated their interest in the plastic waste issue as either "not at all interested," "somewhat of an interest," or "high interest." Each option had an associated numerical value via a Likert scale to measure mean and standard deviation. Participants then self-assessed their problem-solving abilities using a five-point scale: (1) "very low ability," (2) "low ability," (3) "moderate ability," (4) "high ability," and (5) "very high ability." Table 4 reports the descriptive statistics.

<u>Variable</u>	<u>Pre-Survey</u>		<u>Mean</u>	<u>Std. Dev</u>	<u>Min</u>	<u>Max</u>
	<u>Number Obs.</u>	<u>Percent</u>				
Interest in the Issue	988		2.039474	0.6731453	1	3
High interest (3)	244	20.75				
Somewhat of an interest (2)	539	54.55				
Not at all interested (1)	205	24.7				
Ability to solve problems	988		3.430162	0.78478	1	5
Very low (1)	13	1.32				
Low (2)	57	5.77				
Moderate (3)	497	50.3				
High (4)	334	33.81				
Very high (5)	87	8.81				

Table 4. Descriptive statistics of Self Perception Variables Pre Survey

The mean numeric value of issue interest was about 2.04 with a roughly 0.67 standard deviation, reflecting mostly “somewhat interested.” Majority of individuals rated their problem-solving skills either “moderate” (50.3%) or “high” (33.81%). Only 13 individuals ranked them “very low.”

Post-Treatment Self-Perception

Post-treatment, we asked additional self-perception questions in which participants judged their own scenario analysis. Participants rated to what degree they felt their second response was compared to their first response with the following options: not at all better, slightly better, moderately better, or significantly better. They also indicated likelihood of applying the techniques learned in the video to other life situations in the future. Options included "extremely likely," "somewhat likely," and "not at all likely." As before, we transformed each response into numerical values to evaluate means, standard deviations, and include in a regression analysis. Table 5 outlines summary statistics of these questions and values.

Post-Video Survey						
Variable	Number Obs.	Percent	Mean	Std. Dev	Min	Max
Apply Move in the future			2.160931	0.6565174	1	3
Extremely likely (3)	305	30.87				
Somewhat likely (2)	537	54.35				
Not at all likely (1)	146	14.78				
Self-Perception of Improvement			2.247976	0.9432993	1	4
Not at all better (1)	237	23.99				
Slightly better (2)	379	38.36				
Moderately better (3)	262	26.52				
Significantly better (4)	110	11.13				

Table 5. Descriptive statistics of Self Perception Variables Post Survey

Majority of participants cited that they were either “somewhat likely” (54.34%) or “extremely likely” (30.87%) to use the move in the future. Self-perception of improvement after the video was more variant with a mean value of about 2.25 (just above “slightly better”) and standard deviation of roughly 0.94.

Confidence Pre- and Post-Treatment

Participants rated their confidence in addressing the town's plastic waste concern on a scale of 1 to 10, with 1 representing "not at all confident" and 10 as "very confident." We gathered confidence data twice, once before and once after treatment, to track any changes. Not every respondent marked a number for unknown reasons. The descriptive results for observations with the information are in Table 6.

Number of Observations Pre-Video: 968				Number of Observations Post-Video: 975			
Confidence in Ability to Solve Problems (Pre)				Confidence in Ability to Solve Problems (Post)			
<u>Mean</u>	<u>Std Dev</u>	<u>Min</u>	<u>Max</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Min</u>	<u>Max</u>
5.989669	2.218633	1	10	6.302158	2.20016	1	10
<u>Pre</u>	<u>Freq</u>	<u>Percent</u>		<u>Post</u>	<u>Freq</u>	<u>Percent</u>	
1	24	2.48		1	27	2.77	

2	47	4.86	2	25	2.57
3	63	6.51	3	49	5.04
4	81	8.37	4	72	7.4
5	220	22.73	5	198	20.35
6	125	12.91	6	140	14.39
7	139	14.36	7	158	16.24
8	138	14.26	8	131	13.46
9	70	7.23	9	94	9.66
10	61	6.3	10	79	8.12

Table 6. Descriptive Statistics of the Confidence to Solve the Problem

Self-reported confidence to solve the problem was fairly consistent before and after the video intervention. Individuals had a mean confidence of 5.99 pre-treatment with a standard deviation of about 2.22. After, individuals averaged a 6.3 confidence with a similar 2.2 standard deviation.

Measuring Improvement

The primary dependent variable in the study is participants' responses to how they would solve the problem in the presented scenario. The responses were open-text short answers reflecting proposed solutions to the hypothetical scenario. Our team employed systematic coding to transform these qualitative responses into quantitative values for analysis. Each response was assigned a binary value labeled as “Score Move” and defined as follows: 1, participants utilized the specified systems thinking move; 0, participant did not utilize the move. The scoring method was the same for pre- and post-treatment responses. We awarded credit only if participants successfully used all elements of the move, regardless of whether they did so intentionally.

To facilitate the assessment of changes, we created a binary indicator variable labeled as “Post.” This primary independent variable noted when in the survey a participant gave a response. A value of 1 represented an observation recorded after watching the video (i.e., post-treatment/intervention), and a value of 0 represented one collected before encountering the video (i.e., pre-treatment/intervention). In summary, each participant provided two qualitative responses transformed into a quantitative value via the “Score Move” variable that was then associated with either before or after the intervention via the “Post” variable. This produced 1,976 observations dividing equal before and after treatment. We list the response scores as descriptive statistics sorted by pre/post-intervention and the move presented in Table 7.

We chose this straightforward coding method for its simplicity and ease of implementation, ensuring consistency. While more sophisticated coding techniques exist, the approach provided a reliable and standardized means of assessing whether or not the explored systems thinking move was present. The framework facilitated efficient data analysis and interpretation, enabling the identification of patterns and trends within the qualitative responses. To supplement our method's potential to oversimplify a respondent's answer, we included a qualitative judgment of participant responses facilitated via generative artificial intelligence detailed further in this paper. We suggest future researchers develop more expansive approaches to measure the presence of systems thinking or DSRP moves based on our preliminary study.

<u>Variable</u>	<u>Pre Intervention (%)</u>		<u>Post Intervention (%)</u>		<u>Total (%)</u>		<u>Total Observations</u>		
	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>Total</u>
Score Move	85.53	14.47	60.83	39.17	73.18	26.82	1446	530	1976
Score Move Dio List	86.29	13.71	53.30	46.70	69.80	30.20	275	119	394
Score Move Zoom In/Out	85.13	14.87	68.21	31.79	76.67	23.33	299	91	390
Score Move Part Party	85.35	14.65	70.20	29.80	77.78	22.22	308	88	396
Score Move RDS Barbell	91.41	8.59	67.68	32.32	79.55	20.45	315	81	396
Score Move P-Circle	79.50	20.50	45.00	55.00	62.25	37.75	249	151	400

Table 7: Descriptive Statistics of the Move Scores Pre- and Post-intervention

Across all moves tested, frequency of move presence after treatment was higher than before treatment. In aggregate, only 14.47% of participants utilized the move before treatment. Later in the survey, 39.17% successfully utilized the move in their solution. We examined these improvements more thoroughly through a robust quantitative and qualitative data analysis to test their validity.

Data Analysis Methodology

This study undertook a comprehensive examination of the collected data, integrating both qualitative and quantitative analysis to yield a nuanced understanding of the effects of video interventions. To supplement the descriptive statistics already reported, we ran econometric regressions both with and without controls. For a qualitative approach, we harnessed generative artificial intelligence to assess intervention impact.

Logistic Model for Quantitative Analysis

Instead of predicting the value of the dependent variable as a linear regression, the logistic model estimates the probability of a binary event occurring given a set of predictors. The logit function transforms the probability into a logarithmic scale of odds (i.e., a ratio of the probability of success to the probability of failure). This model provides coefficients easily interpreted as odds ratios, allowing us to understand the relative impact of independent variables on the probability of the event. In our case, we wanted to assess the intervention's effect on the probability of observing the systems thinking move while controlling for demographics and individual perception. The logistic model is thus a suitable choice.

In panel data, observations from the same individual are commonly correlated due to characteristics of that person not present in others. If unaccounted for when analyzing data, this correlation can bias estimated standard errors and lead to incorrect statistical inference. Including individual clustering adjusts standard errors to reflect the correlation, providing more precise and reliable estimates of the model parameters and confidence intervals. This precision is particularly relevant in logit models, as clustering can help correct intraclass correlation of observations and ensure a more accurate assessment of the relationships between variables. In our study, the individual clustering process grouped pre- and post-intervention observations for each participant together to estimate fixed or random effects specific to each individual. Accordingly, the general logistic regression model in our analysis is as follows:

$$\text{Logit}(P(Y_i = 1)) = \beta_0 + \beta_1 \text{Post}_i + \text{Controls}_i + u_i$$

In interpreting the results of the model, the binary nature of the dependent variable (Score Move, represented as Y_i above) and the independent variable (Post) is essential to understanding results. The subscripted “i” denotes individual clustering. The coefficient β_1 associated with the "Post" variable indicates the change in logit odds ratio of observing the move post- vs. pre-intervention, holding all other variables constant. Exponentiating the coefficient yields the direct odds ratio. We examined whether the value of the ratio is greater or less than 1 to interpret whether observing the move is more or less likely.

An odds ratio greater than 1 indicates a positive association between the independent variable and the occurrence of the event of interest. In other words, as the independent variable increases, the probability of observing the event of interest also increases. If the odds ratio is less than 1, the independent variable is negatively associated with the event of interest. In this case, as the independent variable increases, the probability of observing the event of interest decreases. A ratio of exactly 1 indicates no association between the independent variable and event occurrence.

In our study, an odds ratio associated with the "Post" variable greater than 1 and statistically significant would suggest a higher likelihood of observing the move post-intervention than pre-intervention. Conversely, an odds ratio less than 1 and statistically significant would indicate a decrease in the likelihood of observing the move. Coefficients associated with other independent variables follow the same interpretation. Each coefficient represents the change in the logit odds of observing the move given a one-unit change in the corresponding variable, holding all other variables constant. All coefficients must be exponentiated to show the direct change in odds ratios.

Overall, the logistic regression model allowed us to assess the effect of the intervention on the probability of observing the move while controlling for other factors, providing valuable insight into the effectiveness of the intervention in promoting systems thinking in addressing plastic waste concerns. Clustering by individual allowed us to capture unobserved variation amongst participants, improving model robustness.

Generative Artificial Intelligence for Aggregate Qualitative Analysis

The responses collected varied in length, ranging from brief one- or two-sentence remarks to more detailed paragraphs. To effectively analyze the data as a whole and complement the quantitative analysis conducted through coding, we utilized the generative artificial intelligence platform ChatGPT for a qualitative perspective. Our approach involved crafting a customized ChatGPT prompt for each move that outlined our analysis objectives and provided a concise overview of the moves depicted in the videos. We inputted all participant responses into the program then tasked ChatGPT via the prompt to compare respondents' answers, identifying any disparities between a given participant's initial and updated responses. All prompts adhered to a consistent format with the only distinction being the description of the move. Table 8 on the following page presents each ChatGPT prompt. In this analysis, we aimed to create a less subjective qualitative improvement assessment. While the results still include biases ingrained in ChatGPT algorithms, they remove unintentional biases of ourselves as researchers overexposed to responses and systems thinking moves.

Dio List Prompt	We conducted a survey to gauge respondents' ability to make distinctions . First, they were asked to assess a town's plastic waste issue. Their initial responses are recorded in the "Assess Issue PRE" table. Then, they watched a short video about clarifying distinctions and were asked to reassess the town's plastic waste system. Their updated responses are in the "Assess Issue POST" table. The video explained that clarifying distinctions involves determining what something is and what it is not. For instance, you might list characteristics of a sandwich under "is," such as having bread and fillings, and characteristics not applicable to a sandwich under "is not," like being flat like pizza. Your task is to analyze each respondent's pre and post answers to identify any differences between their initial and updated assessments.
Zoom In/Out Prompt	We conducted a survey to gauge respondents' ability to identify the parts and whole of any object, idea or issue . First, they were asked to assess a town's plastic waste issue. Their initial responses are recorded in the "Assess Issue PRE" table. Then, they watched a short video about part-whole systems and were asked to reassess the town's plastic waste system. Their updated responses are in the "Assess Issue POST" table. The video explained that structuring our thinking involves identifying parts and wholes of any object, idea, or issue. For example, when considering a rose, we can zoom in to recognize its individual parts like the stem, roots, or petals, or zoom out to see it as part of a larger whole like a garden or symbol of love. Your task is to analyze each respondent's pre and post answers to identify any differences between their initial and updated assessments.
Part Party Prompt	We conducted a survey to gauge respondents' ability to identify parts and understand their relationships within a system . First, they were asked to assess a town's plastic waste issue. Their initial responses are recorded in the "Assess Issue PRE" table. Then, they watched a short video about parts and their relationships to each other, and were asked to reassess the town's plastic waste system. Their updated responses are in the "Assess Issue POST" table. The video explained the concept of identifying parts and understanding their relationships within a system. For instance, in a successful business, various departments like marketing, sales, and operations represent the parts that collectively contribute to the whole. However, each department's success relies on its relationships with others. The sales team needs insights from marketing, and operations ensure all departments have necessary resources. Your task is to analyze each respondent's pre and post answers to identify any differences between their initial and updated assessments.
RDS Barbell Prompt	We conducted a survey to gauge respondents' ability to identify relationships, distinguish them, and zoom in on the components . First, they were asked to assess a town's plastic waste issue. Their initial responses are recorded in the "Assess Issue PRE" table. Then, they watched a short video about parts and their relationships to each other, and were asked to reassess the town's plastic waste system. Their updated responses are in the "Assess Issue POST" table. The video explained the concept of identifying relationships, naming them, and then zooming in to examine their components. For example, when considering the relationship between two individuals, various terms like marriage, friendship, or enemies can be used to describe it. Zooming in on the relationship of marriage, one might identify components such as shared finances, children, and love. Relationships can be both physical, like the binding of a book, and abstract, like communication between a successful boss and their employees. Your task is to analyze each respondent's pre and post answers to identify any differences between their initial and updated assessments.
P-Circle Prompt	We conducted a survey to gauge respondents' ability to gather perspectives and consider them within a broader context . First, they were asked to assess a town's plastic waste issue. Their initial responses are recorded in the "Assess Issue PRE" table. Then, they watched a short video about parts and their relationships to each other, and were asked to reassess the town's plastic waste system. Their updated responses are in the "Assess Issue POST" table. The video explained the concept of gathering perspectives when analyzing an object, idea, or issue. For instance, when considering the implementation of school uniforms, students, teachers, and parents may be viewing the issue from different points. Perspectives can extend to factors such as affordability, color, or fashion. Your task is to analyze each respondent's pre and post answers to identify any differences between their initial and updated assessments.

Table 8: ChatGPT Prompts for Qualitative Analysis

Analysis Results

The results of our analysis are divided into two components: quantitative findings derived from econometric regressions and qualitative insights obtained via ChatGPT. Together, they offer a comprehensive view of the impact of the video interventions on participants' systems thinking and problem-solving abilities.

Quantitative Logit Regression Models

Tables 9, 10, and 11 provide a summary of the key findings from the regressions. In all tables and writing, we exponentiated all logit odds ratios to facilitate a clearer comprehension of the coefficients and their implications. Standard errors are clustered by individuals (notated as “robust seeform” in tables) for a more robust model. While we ran regressions including the self-perception and confidence levels to test their relevance as confounding factors, none were significant and we do not include them in these results. Our basic regressions include all 1,976 observations. Regression models with controls limited observations to only individuals that provided a response to every variable of interest—1,932 responses.

VARIABLES	(1) Logit	(2) Logit + Controls
Score Move		
Post	3.805*** (0.385)	4.050*** (0.433)
Gender		1.243* (0.150)
Age		
25 to 34 years		1.293 (0.313)
35 to 44 years		1.631* (0.416)
45 to 54 years		1.448 (0.369)
55 to 64 years		1.337 (0.369)
65 to 74 years		1.616* (0.451)
75 or older		0.601 (0.292)
Level of Education		
Associate Degree		0.682* (0.154)
Bachelor's Degree		0.661** (0.109)
Graduated High School		0.260*** (0.0664)
Some College		0.401*** (0.105)
Trade /Technical School		0.450***

		(0.104)
Ethnicity/Race		
Hispanic/Latino		1.091 (0.257)
Black/African American		0.871 (0.169)
Asian		1.765** (0.447)
Other		1.376* (0.252)
Political Stance		
Extremely Conservative		1.031 (0.301)
Extremely Liberal		2.131*** (0.467)
Liberal		1.277 (0.230)
Moderate		1.211 (0.224)
Constant	0.169*** (0.0153)	0.129*** (0.0412)
Observations	1,976	1,932

Robust seeform in parentheses; *** p<0.01, ** p<0.05, * p<0.1; exponentiated coefficients.

Table 9: Aggregate Model

Table 9 provides an overview of the aggregated findings from the five surveys. The column illustrates coefficients without controlling for any additional variables other than before or after the intervention. The second column includes controls for socio-demographic factors such as gender, age, educational level, race/ethnicity, and political stance.

The key findings from Table 9 underscore a significant and positive effect in likelihood of exhibiting the systems thinking move after the intervention. In the simple model, exposure to the video increased the likelihood of attaining a score of 1 by approximately 3.80 times compared to not having viewed the video. This coefficient is statistically significant at the 99% confidence level. These results remain consistent in the model incorporating demographic controls. In that model, watching the video elevated the probability of achieving a score of 1 by approximately 4.05 times with similar significance, *ceteris paribus*.

Our analysis of control variables revealed interesting patterns. While females showed a slightly higher likelihood of achieving a score of 1, this lacked strong statistical significance at only 90%. Age played a more definitive role, with those aged 35-44 more likely to achieve a score move of 1 compared to the 18-34 group. This trend continued in older age groups, although only the 35-44 and 65-74 groups reached a significant level with 90% confidence. Level of education demonstrated the most consistent and significant impact, with lower educational attainment associated with a decreased probability of achieving a score of 1 relative to those with advanced degrees. Regarding ethnicity and race, Asian participants showed a significantly higher likelihood of achieving a score of 1 than White participants. Finally, extreme liberals were significantly more likely than conservatives to achieve a score move of 1, with other political stances not demonstrating any significant effect.

The overall significance of each category cannot be interpreted directly via individual coefficient p-values as these represent the change in logit odds compared only to the reference category rather than a null value. For example, if we have a categorical variable with three levels (e.g., Ethnicity/Race), the coefficients for each level represents the change in the logit odds compared only to the reference level (e.g., White individuals in the second column regression of Table 9). Therefore, we performed a global significance test to assess the overall significance of categorical variables in the model. The test showed significance levels for age, level of education, ethnicity/race, and political stance similar to those in Table 9, education stood out as the only variable exhibiting significance across all levels.

Following the aggregate analysis, we ran models for each individual move. This allowed us to compare how each move influenced the probability of achieving a score of 1. Results are in Table 10.

VARIABLES	(1) Dio List	(2) Zoom In/Out	(3) Part Party	(4) RDS Barbell	(5) P-Circle
Score Move					
Post	5.517*** (1.284)	2.668*** (0.616)	2.474*** (0.566)	5.085*** (1.330)	4.740*** (0.998)
Constant	0.159*** (0.0330)	0.175*** (0.0353)	0.172*** (0.0346)	0.0939*** (0.0239)	0.258*** (0.0453)
Observations	394	390	396	396	400

Robust seeform in parentheses; *** p<0.01, ** p<0.05, * p<0.1; exponentiated coefficients.

Table 10: Bivariate regression analysis per move

For Dio List (Column 1), the participants were 5.51 times more likely to exhibit the move after watching the video than before. Similarly, for Zoom In/Out (Column 2), watching the video increased the odds of exhibiting the move 2.66 times. Watching the Part Party video (Column 3) increased the probability of exhibiting the corresponding move by 2.47 times. For RDS (Column 4), the model suggests that participants who underwent that intervention were 5.085 times more likely to exhibit the move. Finally, for P-Circle (Column 5), participants were 4.74 times more likely to showcase the move after intervention. All of these results are significant at the 99% confidence level, supporting a positive impact on ability to apply each move across the board.

One of the most intriguing findings was the minimal impact of demographics on the likelihood of achieving a score of 1 regardless of whether before or after watching the video with few exceptions other than education level. Table 11 provides regression results by move inclusive of our demographic controls.

VARIABLES	(1) Dio List	(2) Zoom In/Out	(3) Part Party	(4) RDS Barbell	(5) P-Circle
Score Move					
Post	6.448*** (1.675)	3.073*** (0.806)	2.673*** (0.682)	5.811*** (1.659)	5.537*** (1.297)
Gender	2.347*** (0.686)	1.928** (0.553)	0.974 (0.289)	0.669 (0.222)	1.185 (0.301)
Age					
25 to 34 years	1.723 (0.868)	0.561 (0.340)	1.106 (0.709)	1.321 (0.772)	1.785 (1.112)

35 to 44 years	1.100 (0.623)	1.276 (0.791)	1.765 (1.188)	1.530 (1.002)	2.209 (1.463)
45 to 54 years	1.320 (0.788)	1.007 (0.641)	1.250 (0.797)	1.581 (1.060)	2.629 (1.710)
55 to 64 years	2.638 (1.734)	0.345 (0.244)	0.594 (0.444)	2.972* (1.923)	2.833 (2.025)
65 to 74 years	1.814 (1.210)	1.207 (0.792)	0.489 (0.390)	3.257 (2.457)	2.784 (1.866)
75 or older	1.944 (1.851)	0.422 (0.520)	0.855 (0.737)	- -	0.451 (0.614)
Level of Education					
Associate Degree	0.817 (0.415)	0.380** (0.185)	0.542 (0.311)	0.672 (0.387)	0.680 (0.371)
Bachelor's Degree	0.677 (0.300)	0.337*** (0.135)	0.600 (0.230)	0.504* (0.205)	1.129 (0.431)
Graduated High School	0.445 (0.252)	0.0718*** (0.0494)	0.162** (0.137)	0.154*** (0.0939)	0.385 (0.224)
Some College	0.257*** (0.126)	0.394* (0.188)	1.184 (1.303)	-	-
Trade/Technical School	0.361 (0.278)	0.236 (0.232)	0.287*** (0.130)	0.451 (0.252)	0.591 (0.280)
Ethnicity/Race					
Hispanic/Latino	2.353* (1.190)	0.725 (0.397)	0.198* (0.194)	1.847 (1.044)	2.085 (1.055)
Black/African American	1.725 (0.861)	1.203 (0.624)	0.456* (0.207)	0.747 (0.441)	1.017 (0.402)
Asian	2.083 (1.158)	2.708 (1.805)	1.596 (1.102)	4.145*** (2.223)	0.607 (0.336)
Other	1.929 (0.890)	1.095 (0.505)	1.231 (0.474)	1.836 (0.865)	1.149 (0.431)
Political Stance					
Extremely Conservative	1.634 (1.052)	0.292 (0.293)	0.821 (0.594)	1.233 (0.842)	1.485 (0.884)
Extremely Liberal	2.035 (0.985)	2.777** (1.417)	1.641 (0.830)	4.244** (2.675)	1.534 (0.705)
Liberal	1.871 (0.765)	1.864 (0.717)	1.034 (0.454)	1.200 (0.629)	0.773 (0.334)
Moderate	1.568 (0.612)	1.731 (0.730)	0.654 (0.311)	1.087 (0.584)	1.281 (0.563)
Constant	0.0458*** (0.0354)	0.217** (0.162)	0.338 (0.277)	0.0703*** (0.0597)	0.111*** (0.0847)
Observations	390	386	380	378	388

Robust seeform in parentheses; *** p<0.01, ** p<0.05, * p<0.1; exponentiated coefficients.

Table 11: Multivariable Regression Analysis by Move

The results in Table 11 underscore the robustness of the results presented in Table 10, further reinforced when adding the possibly confounding demographic variables. Upon conducting the joint test for Age,

Level of Education, Ethnicity/Race, and Political Stance, the outcomes align consistently with the significances observed in Table 11.

Finally, we ran a regression model with interaction terms for the analyzed demographics and our “Post” variable. In statistical analysis, interactions help capture the complexity of relationships not fully explained by individual variables alone. They allow us to investigate if one variable's effect on the outcome depends on the level or presence of another. In this study, an interaction between the “Post” and “Level of Education” variables can reveal whether the effect of the intervention itself depended on participants’ education levels. This interaction provides insight into how the impact of the treatment differs across backgrounds, offering a more nuanced understanding of its effectiveness.

We ran an interaction model specifically for Level of Education and Post, but the regression did not yield significant results for the interaction terms (see Appendix E). This outcome suggests that the effect of the intervention does not significantly vary based on a participants’ educational levels. While previous analysis demonstrated the significance of educational level in achieving better move scores generally, the lack of significance in the interaction term indicates that improvement from before and after the video is not necessarily associated with education level. This suggests that unexplored factors beyond the intervention may influence the relationship between educational level and the exhibition of the move.

Qualitative AI Analysis Results

The qualitative results obtained through the analysis conducted with ChatGPT revealed distinctive and significant patterns in the pre and post-intervention responses. The application of ChatGPT allowed for a detailed analysis of participants’ responses before and after intervention, offering insights into how their perceptions and approaches to the presented issue evolved.

Aggregate Assessment

ChatGPT’s analysis for each move was comprehensive, with both overarching trends across all respondents and specific changes for each participant. Table 12 on the following page provides the first three general trend observations for each move. Overall, ChatGPT noted a shift towards more systemic thinking after intervention, transcending the perception of plastic waste as a standalone issue and recognizing it within a broader environmental and social context.

In the Dio List survey, ChatGPT highlighted an enhanced ability among respondents to discern finer distinctions and categorize aspects of the plastic waste issue more effectively. Moreover, participants displayed a heightened focus on actionable solutions, distinguishing between practical, feasible remedies and those less likely to yield results. The Zoom In/Out responses garnered a shift towards recognizing the micro perspective of an individual alongside the macro perspective of the whole community. Regarding the RDS move, the post-video responses held an increased recognition of relationships and more specific interactions. In the Part Party survey, responses moved towards discussing relationships within systems. Lastly, in the P-Circle survey, participants demonstrated heightened awareness gathering diverse perspectives and engaging in a more collaborative problem-solving process.

Dio List	Zoom In/Out	Part Party	RDS Barbell	P-Circle
Sharper Distinctions in Problem Identification: Post-video, respondents displayed a clearer ability to distinguish between different aspects of the plastic waste issue. They began categorizing aspects of the problem more distinctly, which allowed for more targeted solutions.	Increased Systemic Thinking: Many respondents moved from proposing specific, isolated actions to considering broader systemic changes. They began to see plastic waste not just as an isolated issue but as part of a larger environmental, economic, and social system.	Increased Focus on Systemic Relationships: After the video, respondents often showed a deeper understanding of how various components of the town's waste management system interact. This included acknowledging the roles of different stakeholders like residents, businesses, and local government in the waste system.	Increased Recognition of Relationships: Post-video, many respondents demonstrated a greater awareness of the relationships within the system managing plastic waste. They moved from viewing actions in isolation to seeing them as interconnected within a broader context. This is analogous to recognizing how different departments in a business (like marketing and operations) are interdependent.	Increased Emphasis on Gathering Perspectives: Post-video responses show a stronger emphasis on understanding the problem from multiple perspectives. This indicates a deeper consideration of how different groups (residents, businesses, government) perceive and are affected by the plastic waste issue.
Enhanced Focus on Actionable vs. Non-actionable Items: Many responses showed a transition towards separating doable actions from less practical ideas. This separation helps in prioritizing efforts that are likely to be more effective.	Recognition of Interconnectedness: Post-video responses often acknowledged the interconnectedness of various factors contributing to plastic waste. Respondents showed a deeper understanding that solving plastic waste issues involves addressing the parts (individual behaviors, specific community actions) and the whole (town-wide systems, broader environmental impacts).	More Comprehensive and Integrated Solutions: Many responses shifted from specific, isolated actions to more integrated and holistic strategies that consider the interaction between various parts of the system—such as improving recycling processes, enhancing community education, and modifying local regulations.	More Holistic Approaches: Respondents started considering broader solutions that involve multiple stakeholders (government, businesses, and residents) and recognizing that each part of the system can influence others. This indicates a shift towards systemic thinking, similar to understanding how a change in one part of an organization affects the whole.	More Inclusive Problem-Solving Approaches: There's a noticeable shift towards soliciting ideas and input from a broader array of stakeholders. This suggests a move from top-down to more participatory decision-making processes in addressing environmental challenges.
Greater Specificity in Responses: After the video, answers tended to be more detailed, with respondents identifying specific types of plastic waste and particular challenges associated with them. This indicates a deeper understanding and analysis of the problem.	Emphasis on Community and Behavioral Change: A noticeable shift was the emphasis on changing behaviors at the individual and community level. Many respondents suggested initiatives to educate and engage the community, emphasizing that lasting solutions require participation from all sectors of the town.	Recognition of Broader Impact: There was a notable increase in the recognition of how local actions can have broader environmental impacts. This reflects a more systemic thinking approach where parts (local actions) are seen in the context of the whole (global environmental impact).	Zooming In on Specific Interactions: Many respondents zoomed in on specific interactions or parts of the waste management system, such as the relationship between consumer behavior and recycling effectiveness. This reflects a deeper dive into understanding specific elements of the problem, akin to dissecting a relationship to understand its components (like shared finances in a marriage).	Recognition of Diverse Factors and Interests: Many respondents acknowledged a variety of factors affecting the plastic waste problem, including economic, social, and logistical considerations. This shift demonstrates a more nuanced approach to problem solving, recognizing the complex interplay of different interests and factors.

Table 12: ChatGPT General Trends by Move

Individual Assessment

While the general patterns indicate a shift in respondents' problem-solving strategies towards systems thinking, ChatGPT's individual assessments reveal more precise ways a participant evolved following the video intervention. Tables 13-17 provide an example from each survey, with the participant's pre- and post-video response alongside ChatGPT's assessment.

Dio List Pre-Video Response Respondent 10004	Dio List Post-Video Response Respondent 10004	ChatGPT Assessment Respondent 10004
I would focus on a two-part plan, one short-term and one long-term. The short-term plan would focus on looking into why too much plastic waste is piling up and finding out the best way to deal with it. I would recommend trying to recycle what can be recycled and looking for how other towns eliminate their waste as two methods to reduce the pileup. For the long-term plan, I would suggest the town begin to wean itself off plastic and move to more environmentally sustainable materials/energy so that this will not be a problem in the future.	I would assess the town's plastic waste concerns and separate them into two categories. What is doable and what is not doable? I would have the town leaders brainstorm on what are possible solutions to the plastic waste concerns and what aren't, giving me reasons why for both examples. This would give me a more comprehensive idea of the specific issues facing the town and I would be able to recommend a clearer path forward.	Respondent 10004: Moved from a generic two-part plan to a more nuanced approach, separating actionable items from non-actionable ones, thus refining the strategy with clear distinctions.

Table 13: ChatGPT Assessment of Respondent 10004 (Dio List)

Respondent 10004 underwent the Dio List treatment. According to ChatGPT, this respondent refined their approach, transitioning from a “generic two-part plan” to a more intricate and pragmatic strategy. This involved emphasizing distinct goals that were attainable versus those that were not.

Zoom In/Out Pre-Video Response Respondent 20006	Zoom In/Out Post-Video Response Respondent 20006	ChatGPT Assessment Respondent 20006
I would make recycling programs required (i.e. through fines), and I would hold companies and organizations who produce and use plastic accountable for the amount they produce or use.	Thinking about the video, I would also take into account asking corporations to stop using so much plastic in their products. Possibly switching to cardboard, paper, etc. would be a better option to tackle the plastic problem from the initial stage, while recycling and fine enforcement would tackle it at the later stage.	Respondent 20006 expanded their approach by not only requiring recycling but also pushing for changes at the production level by suggesting alternatives to plastic in products.

Table 14: ChatGPT Assessment of Respondent 20006 (Zoom In/Out)

Respondent 20006, given the Zoom In/Out intervention, expanded their strategy significantly. They not only advocated for mandatory recycling at the individual level but also proposed macro-level changes in production, such as exploring alternatives to plastic in manufacturing. This approach underscores the fundamental aspect of the move.

Part Party Pre-Video Response Respondent 30006	Part Party Post-Video Response Respondent 30006	ChatGPT Assessment Respondent 30006
I would first look into where the waste is coming from. Is it plastic waste from particular companies or from the citizens of the town? I'd suggest increasing the number of recyclable containers on the streets. If the town didn't have a recycling program, where recyclables are separated and put to the street in a bin, I'd suggest implementing that. We could provide incentives to the citizens to encourage them to utilize the new receptacles.	I'd look into who the waste issue falls on, i.e the town who'd need to pick up the waste. I'd delve further to see if that specific department had means of improving the situation, such as setting up recycling stations/bins around the town. I'd look to the treasury to see what money we had to combat this issue.	Respondent 30006 initially focused on identifying the sources of waste and suggested increasing recycling bins. Post-video, their approach included examining the responsibilities of the town in waste management and looking at financial resources available for addressing the issue, indicating a shift to a more systemic view.

Table 15: ChatGPT assessment of Respondent 30006 (Part Party)

Respondent 30006, who watched the Part Party video, delved into the town's involvement in waste management. They suggested exploring financial resources to tackle the issue, signifying a shift towards a more systemic approach to addressing the plastic waste problem.

RDS Pre-Video Response Respondent 40004	RDS Barbell Post-Video Response Respondent 40004	ChatGPT Assessment Respondent 40004
I would see how much plastic waste they have, what they are doing with the waste, how much it costs to recycle it and how it is impacting the environment.	I would check the relationship between the town and the plastic waste, see how it affects the town, how it can be fixed, steps to get the town people to decrease their use of plastics and get government officials to help the town with getting rid of their plastic waste.	Respondent 40004 moved from a general assessment of the plastic waste situation to a more focused analysis on the relationship between the town and its plastic waste, suggesting more targeted strategies to engage the community and government.

Table 16: ChatGPT assessment of Respondent 40004 (RDS Barbell)

Following the RDS Barbell video, Respondent 40004 advanced from a broad assessment of the problem to grasping the crucial relationships and interdependencies among the town, individuals, and government. Additionally, they discerned the distinct roles each entity plays in addressing plastic waste issues.

P-Circle Pre-Video Response Respondent 50005	P-Circle Post-Video Response Respondent 50005	ChatGPT Assessment Respondent 50005
I would have the town set aside funds to buy a huge plastic shredder. I would also reach out to various environmental groups to see if there are any companies who can use shredded plastics and would be willing to purchase the town's shredded waste.	I would get the perspectives of citizens in the community. Then I would get perspectives of environmental groups as well as the perspectives from the town's engineering team.	Respondent 50005 changed from a logistic and somewhat isolated approach (buying a shredder) to gathering varied viewpoints (citizens, environmental groups, engineers) to find a more integrated solution.

Table 17: ChatGPT assessment of Respondent 50005 (P-Circle)

After undergoing the P-circle intervention, Respondent 50005 transitioned from an isolated approach to embracing a broader perspective that engaged multiple parties, leading to a more integrated approach.

In summary, the post-intervention responses of participants demonstrated a shift from narrow, isolated solutions towards collaborative, systemic approaches. These changes imply that a brief, one-minute intervention had a discernible impact on how respondents framed their assessments.

Discussion

In a world characterized by wicked problems and volatility, uncertainty, complexity, and ambiguity (VUCA), individuals often rely on simplistic, linear, and isolated approaches (i.e., LAMO thinking) to address challenges. However, our empirical research provides evidence that systems thinking, particularly through the lens of DSRP theory and associated moves, offers a promising strategy for effectively tackling complex issues. With a less than two-minute intervention, we saw significant shifts towards more systemic thinking in respondents. Based on the comprehensive analysis of both quantitative and qualitative findings, results indicate a clear positive effect of the video interventions with significance at the 0.01 level, or 99% confidence. Figure 8 visual represents the shift in move usage across the study.

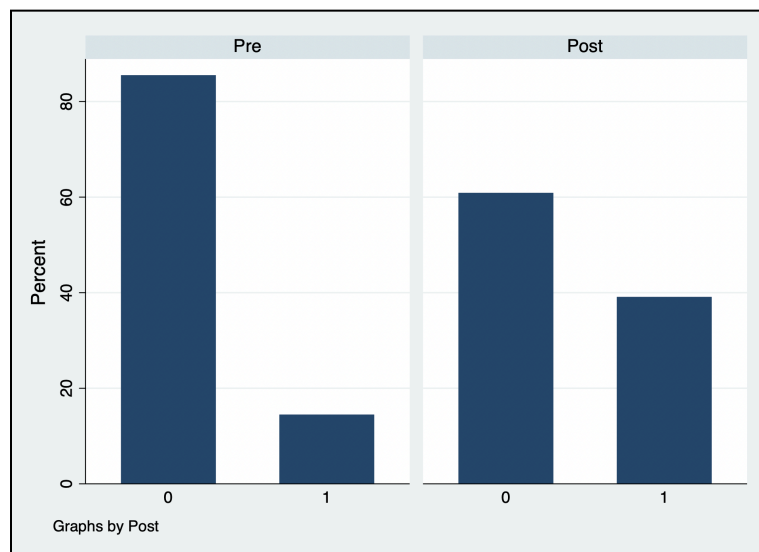


Figure 8: Descriptive Statistics of Move Scores Pre- and Post-Intervention

The presence of the move within response before participants watched the video interventions aligns with DSRP theory in that these structures of our thinking are universal, regardless of intention. By bringing greater awareness to the structure in the short treatment (i.e., metacognition), we saw an increase in directly addressing these structures via the moves.

Our quantitative regression analyses underscore the significant impact of education in expressing a response in the clear structure of a systems thinking move. However, as revealed in our interaction regression, education level itself did not significantly affect improvement from before to after watching the video. This suggests that while education can influence a general ability to express thoughts in a deliberate systems thinking manner, education level itself does not preclude an individual from improving their thinking via an intervention.

Furthermore, qualitative analysis results reveal a notable transition towards more comprehensive problem-solving approaches following the interventions. Participants exhibited a shift from narrow and isolated solutions to broader considerations involving multiple stakeholders. This transition highlights the effectiveness of video interventions in promoting systemic thinking among participants. The diversity of tools utilized in the interventions also proves crucial in addressing different aspects of systems thinking.

From focusing on critical relationships to considering multiple perspectives, each intervention made a unique contribution to the development of participants' response. This underscores the importance of employing a variety of approaches in promoting systemic thinking and problem solving.

While previous research focused on simple observational scenarios [10], our study represents a significant contribution by demonstrating DSRP theory's influence on thinking through real-life policy problems. This underscores the relevance of our findings to policy formulation and decision-making processes in practical contexts. Additionally, our analysis reveals no discernible differences based on demographic factors like gender, political stance, or age, indicating the broad applicability of interventions. Interestingly, despite quantitative and qualitative analysis revealing a shift towards systemic thinking, participants seemed relatively unaware of their own improvement as highlighted by unchanging self-reports of problem-solving confidence and an assertion of only a "slightly better" policy solution after intervention. This warrants further investigation into the underlying factors influencing self-perceptions of confidence in problem solving and metacognition.

Overall, our study demonstrates significant positive outcomes resulting from very brief interventions, highlighting the potential for rapid improvement in systems thinking skills. These findings provide a solid foundation for future research and practical applications in fields such as education, management, and policy. Importantly, our focus on DSRP tools does not negate the potential value of other problem-solving approaches. Even participants who employed a specific approach like Cost-Benefit Analysis within their initial response exhibited a shift towards systemic thinking, indicating the potential to improve existing policy-making frameworks while introducing systems thinking strategies. Our Systems Literature Review espoused the dire need for a more evidence-based approach to policy education and decision making grounded in principles of systems thinking. We can better equip decision-makers to tackle the complexities of wicked problems by implementing more empirically-tested educational strategies like the DSRP moves tested in our study.

Limitations

While our study offers valuable insights into the impact of the targeted video interventions on systems thinking skills, we encountered limitations in our design. First, the sample consisted of participants from the United States. Additionally, our use of a hypothetical scenario may not capture the full complexity and variability of real-world decision making. We also restricted our potential impact by testing each move individually, as the Pareto Law research on cognitive moves [59] suggests that all five moves are needed for the greatest impact. These issues limit the generalizability of our findings.

The study further focused on immediate post-intervention effects, neglecting the assessment of long-term effects on thinking. Similarly, a real world educational intervention would likely last longer than one to two minutes, potentially spanning days or weeks. Our quasi-experimental design also lacked a control group, so we cannot attribute changes solely to the interventions. Studies with more in-depth interventions, experimental designs, and long-term participation may yield different results.

Lastly, the binary coding approach used to analyze responses may have oversimplified the nuanced nature of participants' thought processes. While our use of ChatGPT aimed to combat this problem, the potential remains a limiting factor. We further recognize our study's restricted focus on DSRP tools. Empirical

studies on other problem-solving methods could reveal similar positive effects, though the current lack of evidence found in our Systems Literature Review suggests the need for more evidence supporting their efficacy. Even with these limitations, we nevertheless saw significant shifts from an intervention barely over one minute. Our study thus provides valuable insights into the effectiveness of targeted interventions in enhancing systemic thinking and underscores the need for further research to explore these concepts.

Recommendations

Based on our findings, we developed the following two recommendations for educators:

- (1) **Teach DSRP-based cognitive moves in all education levels:** Integrating systems thinking—specifically the five studied cognitive moves—into educational settings holds immense potential for fostering critical thinking, problem solving, and deeper understanding of complex problems. By introducing these concepts early on, students can develop an intuitive sense for interconnectedness and complexity across domains. Small-scale interventions, such as incorporating cognitive move exercises into existing curriculum modules could serve as effective starting points. These interventions can help students recognize and analyze feedback loops, identify obscured relationships, and conduct analyses across scales. In nurturing these systems thinking skills, educators can empower students to tackle challenges creatively and ethically while preparing them for the complexities of our contemporary world.
- (2) **Make DSRP and the five cognitive moves a core tenet of policy education:** To foster a systemic approach in policy education, institutions should integrate the DSRP approach to systems thinking via the five studied cognitive moves throughout their curricula. Such a shift would move curricula beyond rote memorization and superficial, politically expedient solutions towards practical application and deeper analysis. Educational programs should prioritize experiential learning, encouraging students to analyze real-world policy challenges through a systems lens that emphasizes distinctions, systems, relationships, and perspectives. By actively engaging with cognitive moves to understand complex systems, students can develop the critical thinking skills necessary to formulate effective solutions to address wicked policy problems.

We also offer the following two recommendations for further research:

- (1) **Develop expanded techniques to easily identify systemic thinking:** Future research should explore the development and refinement of qualitative coding techniques to better understand the identification and barriers to the uptake of systems thinking. This could involve analyzing the tone of responses, particularly those expressing indignation or resistance after training. Such analysis could reveal underlying attitudes and beliefs that hinder the adoption of systems thinking. Additionally, exploring discrepancies amongst the significance levels found in aspects of our analysis could shed light on potential overconfidence in problem-solving skills or misunderstanding of key concepts. By identifying these barriers, educators can tailor approaches to better address individual needs and learning styles, ultimately fostering a more widespread adoption of systems thinking.

- (2) **Longitudinal and comparative studies for more in-depth study:** Our research can serve as a start for longitudinal studies examining the efficacy of more extensive training over longer periods. For example, researchers may look at graduates' career trajectories and policy achievements. Comparative studies could evaluate the efficacy of multiple pedagogical approaches, such as case studies versus simulations, to determine which methods most effectively foster systems thinking skills. These studies could also investigate whether certain teaching techniques better equip students to address complex policy challenges marked by political polarization and entrenched viewpoints.

Conclusion

Our study successfully demonstrates the profound impact that targeted educational interventions can have on enhancing systems thinking capabilities among a broad demographic. By employing the Distinctions Systems Relationships Perspectives (DSRP) model and specifically the five DSRP moves, we were able to effectively shift participants towards a more systematic thinking. The significant improvement observed post-intervention highlights the potential of systems thinking to empower individuals with the tools necessary to tackle complex and interconnected societal challenges more effectively.

The implications for policy education are substantial. Integrating systems thinking into policy curricula could revolutionize how future policymakers approach problem solving and decision making. Our findings advocate for a reevaluation of current educational frameworks to include evidence-based systems thinking methods such as DSRP theory to cultivate a new generation of policymakers better equipped to navigate the complexities of modern governance. By bridging the gap between theory and practice, this research confirms the efficacy of systems thinking education and elucidates the need for educational reform that emphasizes holistic, interdisciplinary approaches to learning. These shifts are crucial to developing capable leaders who can devise innovative solutions to the most pressing wicked problems of our time.

Author Contribution

The whole research resulted from intense collaboration amongst the entire author team. WA, JB, AI, TL, BN, JS, and MW conceived, designed, and implemented the study with guidance and leadership from Cornell University faculty advisors and Cabrera Research Lab heads LC and DC. WA, BN, JS, and MW carried out the Systems Literature Review (SLR) with BN leading visual development while JB, AI, and TL implemented data analysis with JB leading graphs and modeling. All authors contributed to the interpretation of our results and developing recommendations and conclusions. The SLR and data analysis teams wrote their respective sections of the manuscript. BN drafted the introduction, AI and JS drafted the discussion, while AI, JS, and MW drafted the recommendations and WA drafted the conclusion. BN led manuscript editing with support from TL and JS. BN managed the project. All authors provided critical feedback to shape the entire research process and manuscript with final oversight from LC and DC.

References

- [1] D. Cabrera, J. T. Mandel, J. P. Andras, and M. L. Nydam, "What is the crisis? Defining and prioritizing the world's most pressing problems," *Front. Ecol. Environ.*, vol. 6, no. 9, pp. 469–475, Nov. 2008, doi: 10.1890/070185.
- [2] N. Steinhall *et al.*, "Wicked Solutions for Wicked Problems," 2023.
- [3] H. W. J. Rittel and M. M. Webber, "Dilemmas in a general theory of planning," *Policy Sci.*, vol. 4, no. 2, pp. 155–169, Jun. 1973, doi: 10.1007/BF01405730.
- [4] D. Cabrera and L. Cabrera, *Systems Thinking Made Simple: New Hope for Solving Wicked Problems in a Complex World*. Ithaca: Odyssean Press, 2015.
- [5] W. G. Bennis and B. Nanus, *Leaders: the strategies for taking charge ; [the four keys of effective leadership]*. Oxford, San Francisco: Jossey-Bass Publ, 1995.
- [6] M. M. Waldrop and M. M. Waldrop, *Complexity: the emerging science at the edge of order and chaos*, 1. Touchstone ed. in A Touchstone book. New York, NY: Touchstone, 1993.
- [7] D. Cabrera and L. Cabrera, "DSRP Theory: A Primer," *Systems*, vol. 10, no. 2, p. 26, Mar. 2022, doi: 10.3390/systems10020026.
- [8] A. Wen *et al.*, "Framework Effectiveness and Prevalence in Public Policy: A survey of the field and a discussion of the need for an agent based systems approach," *J. Syst. Think.*, vol. 2, no. 3, May 2022, doi: 10.54120/jost.000060.
- [9] Yeni Oktavia Mulyono, Unur Sukhbaatar, L. Cabrera, and D. Cabrera, "'Hard' and 'Soft' Methods in Complex Adaptive Systems (CAS) Agent Based Modeling (ABM) and the Agent Based Approach (ABA)," 2021, doi: 10.13140/RG.2.2.31260.82563.
- [10] D. Cabrera, L. Cabrera, and E. Cabrera, "The 'Fish Tank' Experiments: Metacognitive Awareness of Distinctions, Systems, Relationships, and Perspectives (DSRP) Significantly Increases Cognitive Complexity," *Systems*, vol. 10, no. 2, p. 29, Mar. 2022, doi: 10.3390/systems10020029.
- [11] D. Cabrera, L. Cabrera, and E. Cabrera, "The Steps to Doing a Systems Literature Review (SLR)." Apr. 06, 2023. doi: 10.54120/jost.pr000019.v1.
- [12] D. N. Boote and P. Beile, "Scholars Before Researchers: On the Centrality of the Dissertation Literature Review in Research Preparation," *Educ. Res.*, vol. 34, no. 6, pp. 3–15, Aug. 2005, doi: 10.3102/0013189X034006003.
- [13] M. J. Page *et al.*, "Declaración PRISMA 2020: una guía actualizada para la publicación de revisiones sistemáticas," *Rev. Esp. Cardiol. Engl. Ed.*, vol. 74, no. 9, pp. 790–799, Sep. 2021, doi: 10.1016/j.rec.2021.07.010.
- [14] M. J. Page *et al.*, "PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews," *BMJ*, p. n160, Mar. 2021, doi: 10.1136/bmj.n160.
- [15] L. Cabrera, J. Sokolow, and D. Cabrera, "Developing and Validating a Measurement of Systems Thinking: The Systems Thinking and Metacognitive Inventory (STMI). In, Routledge Handbook of Systems Thinking," 2021, doi: 10.13140/RG.2.2.28639.38566.

- [16] D. Cabrera, L. Cabrera, and G. Midgley, "The Four Waves of Systems Thinking," 2021, doi: 10.13140/RG.2.2.32099.68649.
- [17] D. Cabrera, L. Cabrera, and E. Cabrera, "Distinctions Organize Information in Mind and Nature: Empirical Findings of Identity–Other Distinctions (D) in Cognitive and Material Complexity," *Systems*, vol. 10, no. 2, p. 41, Mar. 2022, doi: 10.3390/systems10020041.
- [18] D. Cabrera, L. Cabrera, and E. Cabrera, "Perspectives Organize Information in Mind and Nature: Empirical Findings of Point-View Perspective (P) in Cognitive and Material Complexity," *Systems*, vol. 10, no. 3, p. 52, Apr. 2022, doi: 10.3390/systems10030052.
- [19] D. Cabrera, L. Cabrera, and E. Cabrera, "Relationships Organize Information in Mind and Nature: Empirical Findings of Action–Reaction Relationships (R) in Cognitive and Material Complexity," *Systems*, vol. 10, no. 3, p. 71, May 2022, doi: 10.3390/systems10030071.
- [20] D. Cabrera, L. Cabrera, and E. Cabrera, "Systems Organize Information in Mind and Nature: Empirical Findings of Part-Whole Systems (S) in Cognitive and Material Complexity," *Systems*, vol. 10, no. 2, p. 44, Apr. 2022, doi: 10.3390/systems10020044.
- [21] D. Cabrera and L. Cabrera, "Developing Personal Mastery in Systems Thinking," *J. Syst. Think.*, vol. 3, 2023, doi: 10.54120/jost.0000043.
- [22] U.S. News & World Report, "Best Graduate Public Affairs Programs." Accessed: Nov. 10, 2023. [Online]. Available: <https://www.usnews.com/best-graduate-schools/top-public-affairs-schools/public-policy-analysis-rankings>
- [23] A. Gębska-Kuczerowska, S. Lahiri, and R. Gajda, "Bridging the Gap between Theory, Practice, and Policy: A Decision-Making Process Based on Public Health Evidence Feasible in Multi-Stage Research on Biological Risk Factors in Poland," *Int. J. Environ. Res. Public. Health*, vol. 17, no. 20, p. 7657, Oct. 2020, doi: 10.3390/ijerph17207657.
- [24] N. Balasubramanian, Y. Ye, and M. Xu, "Substituting Human Decision-Making with Machine Learning: Implications for Organizational Learning," *Acad. Manage. Rev.*, vol. 47, no. 3, pp. 448–465, Jul. 2022, doi: 10.5465/amr.2019.0470.
- [25] A. Roberts, "Risk, Reward, and Resilience Framework: Integrative Policy Making in a Complex World," *J. Int. Econ. Law*, vol. 26, no. 2, pp. 233–265, May 2023, doi: 10.1093/jiel/jgad009.
- [26] A. Malkamäki, P. M. Wagner, M. Brockhaus, A. Toppinen, and T. Ylä-Anttila, "On the Acoustics of Policy Learning: Can Co-Participation in Policy Forums Break Up Echo Chambers?," *Policy Stud. J.*, vol. 49, no. 2, pp. 431–456, May 2021, doi: 10.1111/psj.12378.
- [27] E. M. Hodge and E. L. Stosich, "Accountability, Alignment, and Coherence: How Educators Made Sense of Complex Policy Environments in the Common Core Era," *Educ. Eval. Policy Anal.*, vol. 44, no. 4, pp. 543–566, Dec. 2022, doi: 10.3102/01623737221079650.
- [28] T. Khare and S. Kapoor, "Behavioral biases and the rational decision-making process of financial professionals: significant factors that determine the future of the financial market," *J. Adv. Manag. Res.*, vol. 21, no. 1, pp. 44–65, Jan. 2024, doi: 10.1108/JAMR-03-2023-0086.
- [29] E. Cerracchio, S. Miletić, and B. U. Forstmann, "Modelling decision-making biases," *Front. Comput. Neurosci.*, vol. 17, p. 1222924, Oct. 2023, doi: 10.3389/fncom.2023.1222924.

- [30] R. D. Lange, A. Chatteraj, J. M. Beck, J. L. Yates, and R. M. Haefner, “A confirmation bias in perceptual decision-making due to hierarchical approximate inference,” *PLOS Comput. Biol.*, vol. 17, no. 11, p. e1009517, Nov. 2021, doi: 10.1371/journal.pcbi.1009517.
- [31] A. D. Ross and S. M. Rouse, “(Young) Generations as Social Identities: The Role of Latino*Millennial/Generation Z in Shaping Attitudes About Climate Change,” *Polit. Behav.*, vol. 44, no. 3, pp. 1105–1124, Sep. 2022, doi: 10.1007/s11109-020-09649-8.
- [32] M. Salehin, “Socio-political and economic correlates influencing abortion policies across the states in America”.
- [33] A. Karimo *et al.*, “Shared Positions on Divisive Beliefs Explain Interorganizational Collaboration: Evidence from Climate Change Policy Subsystems in 11 Countries,” *J. Public Adm. Res. Theory*, vol. 33, no. 3, pp. 421–433, Jun. 2023, doi: 10.1093/jopart/muac031.
- [34] L. Van Beek, N. Mouter, P. Pelzer, M. Hajer, and D. Van Vuuren, “Experts and expertise in practices of citizen engagement in climate policy: a comparative analysis of two contrasting cases,” *Clim. Change*, vol. 177, no. 1, p. 10, Jan. 2024, doi: 10.1007/s10584-023-03659-1.
- [35] W. Tao, C. Hong, W.-H. S. Tsai, and B. Yook, “Publics’ communication on controversial sociopolitical issues: extending the situational theory of problem solving,” *J. Appl. Commun. Res.*, vol. 49, no. 1, pp. 44–65, Jan. 2021, doi: 10.1080/00909882.2020.1849770.
- [36] M. Palmer-Abbs, P. Deshpande, and C. W. Karl, “Enabling transition thinking on complex issues (wicked problems): A framework for future circular economic transitions of plastic management in the Norwegian fisheries and aquaculture sectors,” *J. Clean. Prod.*, vol. 449, p. 141420, Apr. 2024, doi: 10.1016/j.jclepro.2024.141420.
- [37] C. V. Castro, “Systems-thinking for environmental policy coherence: Stakeholder knowledge, fuzzy logic, and causal reasoning,” *Environ. Sci. Policy*, vol. 136, pp. 413–427, Oct. 2022, doi: 10.1016/j.envsci.2022.07.001.
- [38] M.-J. Chen, H.-C. She, and P.-Y. Tsai, “The effects of online simulation-based collaborative problem-solving on students’ problem-solving, communication and collaboration attitudes,” *Educ. Inf. Technol.*, Mar. 2024, doi: 10.1007/s10639-024-12609-y.
- [39] C. Kim and K. Y. Nam, “Policy Puzzle Game: making policy ideas feasible and acceptable in policy co-design,” *CoDesign*, vol. 18, no. 4, pp. 448–465, Oct. 2022, doi: 10.1080/15710882.2021.1995440.
- [40] K. Hara *et al.*, “Policy design by ‘imaginary future generations’ with systems thinking : a practice by Kyoto city towards decarbonization in 2050,” *Futures*, vol. 154, p. 103272, Dec. 2023, doi: 10.1016/j.futures.2023.103272.
- [41] X. Liu, J. Gu, and J. Xu, “The impact of the design thinking model on pre-service teachers’ creativity self-efficacy, inventive problem-solving skills, and technology-related motivation,” *Int. J. Technol. Des. Educ.*, vol. 34, no. 1, pp. 167–190, Mar. 2024, doi: 10.1007/s10798-023-09809-x.
- [42] J. C. Sanabria-Zepeda, P. G. Olivo-Montaña, I. Artemova, and A. J. Argüelles-Cruz, “Prospective narratives on global issues: An AI-based pedagogical model for assessing complex thinking,” *J. Technol. Sci. Educ.*, vol. 14, no. 1, p. 184, Jan. 2024, doi: 10.3926/jotse.2445.
- [43] C.-Y. Wang, S. Chen, and M.-Y. Huang, “Exploring medical students’ metacognitive and regulatory

- dimensions of diagnostic problem solving,” *Med. Educ. Online*, vol. 28, no. 1, p. 2210804, Dec. 2023, doi: 10.1080/10872981.2023.2210804.
- [44] B. Nicolay *et al.*, “Unsuccessful and successful complex problem solvers – A log file analysis of complex problem solving strategies across multiple tasks,” *Intelligence*, vol. 101, p. 101793, Nov. 2023, doi: 10.1016/j.intell.2023.101793.
- [45] B. Nicolay *et al.*, “Examining the development of metacognitive strategy knowledge and its link to strategy application in complex problem solving – a longitudinal analysis,” *Metacognition Learn.*, vol. 17, no. 3, pp. 837–854, Dec. 2022, doi: 10.1007/s11409-022-09324-9.
- [46] M. Y. Chen, E. Rouse, and A.-M. Morrissey, “Intentionality and the active decision-making process in play-based learning,” *Aust. Educ. Res.*, Jun. 2023, doi: 10.1007/s13384-023-00644-6.
- [47] N. Munoz-del-Campo, “The problem-based learning as a pedagogical framework for teaching master of public policy and master of public administration programs in Latin America,” *Teach. Public Adm.*, vol. 41, no. 3, pp. 408–426, Oct. 2023, doi: 10.1177/01447394221124818.
- [48] O. G. El-Taliawi, S. Nair, and Z. Van Der Wal, “Public policy schools in the global south: a mapping and analysis of the emerging landscape,” *Policy Sci.*, vol. 54, no. 2, pp. 371–395, Jun. 2021, doi: 10.1007/s11077-020-09413-z.
- [49] C. Cronley, E. R. Murphy, and J. C. Petrovich, “Homelessness From a Holistic Paradigm: Bridging Gaps in Curriculum Through Supplemental Education Opportunities,” *J. Soc. Work Educ.*, vol. 56, no. sup1, pp. S16–S27, Jun. 2020, doi: 10.1080/10437797.2020.1723762.
- [50] R. Balaz, “Be ready for the clash of powers: theorising power for teaching policy practice in social work,” *Eur. J. Soc. Work*, vol. 26, no. 4, pp. 773–785, Jul. 2023, doi: 10.1080/13691457.2022.2161485.
- [51] G. Andreottola and C. Li, “Polarization and Policy Design,” *J. Polit. Econ. Microecon.*, vol. 2, no. 1, pp. 1–42, Feb. 2024, doi: 10.1086/726844.
- [52] Raharjo, E. Solihatin, Moh. Maiwan, and Y. Kardiman, “Development of Controversial Issues Learning Models in Improving Student’s Critical Thinking Skills,” *Stud. Learn. Teach.*, vol. 4, no. 3, pp. 490–498, Dec. 2023, doi: 10.46627/silet.v4i3.226.
- [53] A. Cordova, J. Lahey, and L. Taghiyeva, “How to implement project-based quantitative classroom projects while supporting curricular design: A case study from a quantitative methods course in a public affairs program,” *Teach. Public Adm.*, vol. 41, no. 2, pp. 284–299, Jul. 2023, doi: 10.1177/01447394221079692.
- [54] S. A. Perun, ““‘Why? Why? Why?’ is the question of the course”: Master’s of Public Administration students’ perspectives on their learning in a standalone ethics course and the implications for ethics education throughout the curriculum,” *Teach. Public Adm.*, p. 01447394231204697, Sep. 2023, doi: 10.1177/01447394231204697.
- [55] D. M. S. Dissanayake and A. K. L. Jayawardana, “The impact of personal sense of power on unethical decision-making: a moderated mediation model of love of money motive and power distance orientation,” *DECISION*, vol. 50, no. 1, pp. 19–34, Mar. 2023, doi: 10.1007/s40622-023-00340-5.
- [56] C. Lawrence, S. Jasanoff, S. W. Evans, K. Raffel, and L. Mahadevan, “Ethics Inside the Black Box:

Integrating Science and Technology Studies into Engineering and Public Policy Curricula,” *Sci. Eng. Ethics*, vol. 29, no. 4, p. 23, Aug. 2023, doi: 10.1007/s11948-023-00440-6.

- [57] N. Brophy and K. J. Mullinix, “Partisan Motivated Empathy and Policy Attitudes,” *Polit. Behav.*, Aug. 2023, doi: 10.1007/s11109-023-09890-x.
- [58] K. S. Rogge and M. Stadler, “Applying policy mix thinking to social innovation: from experimentation to socio-technical change,” *Environ. Innov. Soc. Transit.*, vol. 47, p. 100723, Jun. 2023, doi: 10.1016/j.eist.2023.100723.
- [59] Cabrera Research Lab, “Glossary of Known Cognitive Moves.” Accessed: May 14, 2024. [Online]. Available: <https://help.cabreraresearch.org/moves-glossary>

Appendices

Appendix A: Bibliography of Scholarly Literature Reviewed

Appendix B: Public Search Results by Title

Appendix C: “Solving Problems” Surveys

Appendix D: Video Interventions

Appendix E: Additional Quantitative Analysis

Appendix F: Full Qualitative ChatGPT Analysis

Appendix A: Bibliography of Scholarly Literature Reviewed

- [1] S. A. Perun, ““Why? Why? Why?” is the question of the course”: Master’s of Public Administration students’ perspectives on their learning in a standalone ethics course and the implications for ethics education throughout the curriculum,” *Teaching Public Administration*, p. 01447394231204697, Sep. 2023, doi: [10.1177/01447394231204697](https://doi.org/10.1177/01447394231204697).
- [2] A. Dissen, “A critical issue: assessing the critical thinking skills and dispositions of undergraduate health science students,” *Discov Educ*, vol. 2, no. 1, p. 21, Aug. 2023, doi: [10.1007/s44217-023-00044-z](https://doi.org/10.1007/s44217-023-00044-z).
- [3] M. D. Pamungkas, S. B. Waluya, S. Mariani, and Isnarto, “A Systematic Review of Complex Problem-Solving in Education and Mathematics Education,” *JHETP*, vol. 23, no. 16, Oct. 2023, doi: [10.33423/jhetp.v23i16.6465](https://doi.org/10.33423/jhetp.v23i16.6465).
- [4] A. Lievens and I. Moons, “A systemic approach of communication in multiple stakeholder settings: challenges and future research directions from a multidisciplinary perspective,” *International Journal of Advertising*, vol. 42, no. 1, pp. 201–226, Jan. 2023, doi: [10.1080/02650487.2022.2150953](https://doi.org/10.1080/02650487.2022.2150953).
- [5] C. McGregor and M. Millar, “A Systemic Lifecycle Approach to Social Policy Practice in Social Work: Illustrations from Irish Child Welfare and Parenting Research and Practice,” *The British Journal of Social Work*, vol. 50, no. 8, pp. 2335–2353, Jan. 2021, doi: [10.1093/bjsw/bcaa194](https://doi.org/10.1093/bjsw/bcaa194).
- [6] E. M. Hodge and E. L. Stosich, “Accountability, Alignment, and Coherence: How Educators Made Sense of Complex Policy Environments in the Common Core Era,” *Educational Evaluation and Policy Analysis*, vol. 44, no. 4, pp. 543–566, Dec. 2022, doi: [10.3102/01623737221079650](https://doi.org/10.3102/01623737221079650).
- [7] J. McConnell, “Adoption for adaptation: A theory-based approach for monitoring a complex policy initiative,” *Evaluation and Program Planning*, vol. 73, pp. 214–223, Apr. 2019, doi: [10.1016/j.evalprogplan.2019.01.008](https://doi.org/10.1016/j.evalprogplan.2019.01.008).
- [8] E. J. Conrad, M. Becker, E. Brandley, E. Saksvig, and J. Nickelson, “Advocacy and Public Policy Perceptions and Involvement of College Health Promotion Students,” *Health Promotion Practice*, vol. 20, no. 5, pp. 730–741, Sep. 2019, doi: [10.1177/1524839919837619](https://doi.org/10.1177/1524839919837619).
- [9] M. Sakamoto, E. Yamaguchi, T. Yamamoto, and K. Wakabayashi, “An intervention study on students’ decision-making towards consensus building on socio-scientific issues,” *International Journal of Science Education*, vol. 43, no. 12, pp. 1965–1983, Aug. 2021, doi: [10.1080/09500693.2021.1947541](https://doi.org/10.1080/09500693.2021.1947541).
- [10] P. Barnes, M. P. Morris, A. L. Pierce, and T. J. Shaffer, “Answering the call: Offering and analyzing civil discourse opportunities in undergraduate public affairs education,” *Journal of Public Affairs Education*, vol. 29, no. 2, pp. 213–231, Apr. 2023, doi: [10.1080/15236803.2022.2148604](https://doi.org/10.1080/15236803.2022.2148604).

- [11] K. S. Rogge and M. Stadler, “Applying policy mix thinking to social innovation: from experimentation to socio-technical change,” *Environmental Innovation and Societal Transitions*, vol. 47, p. 100723, Jun. 2023, doi: [10.1016/j.eist.2023.100723](https://doi.org/10.1016/j.eist.2023.100723).
- [12] M. R. Taleyarkhan, A. Lucietto, N. Hobson, and T. Azevedo, “Approach to problem solving and use of intuition by engineering technology students,” *JGER*, vol. 7, no. 1, pp. 81–98, Mar. 2023, doi: [10.5038/2577-509X.7.1.1174](https://doi.org/10.5038/2577-509X.7.1.1174).
- [13] M. J. Dolliver, J. L. Kenney, and L. Williams Reid, “Assessing the Relationships Between Past Victimization, Perceived Risk of Future Victimization, and Controversial Criminal Justice Policies Using Structural Equation Modeling,” *Criminal Justice Policy Review*, vol. 33, no. 1, pp. 74–98, Feb. 2022, doi: [10.1177/08874034211018235](https://doi.org/10.1177/08874034211018235).
- [14] R. Balaz, “Be ready for the clash of powers: theorising power for teaching policy practice in social work,” *European Journal of Social Work*, vol. 26, no. 4, pp. 773–785, Jul. 2023, doi: [10.1080/13691457.2022.2161485](https://doi.org/10.1080/13691457.2022.2161485).
- [15] T. Khare and S. Kapoor, “Behavioral biases and the rational decision-making process of financial professionals: significant factors that determine the future of the financial market,” *JAMR*, vol. 21, no. 1, pp. 44–65, Jan. 2024, doi: [10.1108/JAMR-03-2023-0086](https://doi.org/10.1108/JAMR-03-2023-0086).
- [16] A. Gębska-Kuczerowska, S. Lahiri, and R. Gajda, “Bridging the Gap between Theory, Practice, and Policy: A Decision-Making Process Based on Public Health Evidence Feasible in Multi-Stage Research on Biological Risk Factors in Poland,” *IJERPH*, vol. 17, no. 20, p. 7657, Oct. 2020, doi: [10.3390/ijerph17207657](https://doi.org/10.3390/ijerph17207657).
- [17] A. A. Alexander and H. Allo, “Building a Climate for Advocacy Training in Professional Psychology,” *The Counseling Psychologist*, vol. 49, no. 7, pp. 1070–1089, Oct. 2021, doi: [10.1177/00110000211027973](https://doi.org/10.1177/00110000211027973).
- [18] E. M. A. Geurts, R. P. Reijts, H. H. M. Leenders, M. W. J. Jansen, and C. J. P. A. Hoebe, “Co-creation and decision-making with students about teaching and learning: a systematic literature review,” *J Educ Change*, vol. 25, no. 1, pp. 103–125, Mar. 2024, doi: [10.1007/s10833-023-09481-x](https://doi.org/10.1007/s10833-023-09481-x).
- [19] T. R. F. Jr, E. Myers, and A. Smith, “Communities of practice empower teachers to tackle thorny problems,” vol. 43, no. 1, 2022.
- [20] J. Limberg, C. Knill, and Y. Steinebach, “Condemned to complexity? Growing state activity and complex policy systems,” *Governance*, vol. 36, no. 2, pp. 575–608, Apr. 2023, doi: [10.1111/gove.12684](https://doi.org/10.1111/gove.12684).
- [21] T. A. Bekele, I. M. Karkouti, and S. Amponsah, “Core conceptual features of successful blended learning in higher education: Policy implications,” *EPAA*, vol. 30, Oct. 2022, doi: [10.14507/epaa.30.7444](https://doi.org/10.14507/epaa.30.7444).
- [22] A. Spaa, N. Spencer, A. Durrant, and J. Vines, “Creative and collaborative reflective thinking to support policy deliberation and decision making,” *Evidence & Policy*, vol. 18, no. 2, pp. 376–390, May 2022, doi: [10.1332/174426421X16474564583952](https://doi.org/10.1332/174426421X16474564583952).

- [23] F. Petersen, H. Brunkhorst, and M. Seeliger, “Critical problems and pragmatist solutions,” *Philosophy & Social Criticism*, vol. 48, no. 10, pp. 1341–1352, Dec. 2022, doi: [10.1177/01914537221114916](https://doi.org/10.1177/01914537221114916).
- [24] N. A. Otieno *et al.*, “Decision-making process for introduction of maternal vaccines in Kenya, 2017–2018,” *Implementation Sci*, vol. 16, no. 1, p. 39, Dec. 2021, doi: [10.1186/s13012-021-01101-7](https://doi.org/10.1186/s13012-021-01101-7).
- [25] D. Serra, “Decision-making: from neuroscience to neuroeconomics—an overview,” *Theory Decis*, vol. 91, no. 1, pp. 1–80, Jul. 2021, doi: [10.1007/s11238-021-09830-3](https://doi.org/10.1007/s11238-021-09830-3).
- [26] Raharjo, E. Solihatin, Moh. Maiwan, and Y. Kardiman, “Development of Controversial Issues Learning Models in Improving Student’s Critical Thinking Skills,” *Stud. Learn. Teach.*, vol. 4, no. 3, pp. 490–498, Dec. 2023, doi: [10.46627/silet.v4i3.226](https://doi.org/10.46627/silet.v4i3.226).
- [27] H. Bovill, R. Waller, and K. McCartan, “Discussing Atypical Sexual Harassment as a Controversial Issue in Bystander Programmes: One UK Campus Study,” *Sexuality & Culture*, vol. 24, no. 5, pp. 1252–1270, Oct. 2020, doi: [10.1007/s12119-019-09682-8](https://doi.org/10.1007/s12119-019-09682-8).
- [28] H. Yang and J. Guo, “Disentangling the negative effects of envy on moral decision-making,” *Curr Psychol*, vol. 42, no. 32, pp. 28493–28504, Nov. 2023, doi: [10.1007/s12144-022-03776-7](https://doi.org/10.1007/s12144-022-03776-7).
- [29] S. M. Stitzlein, “Divisive Concepts in Classrooms: A Call to Inquiry,” *Stud Philos Educ*, vol. 41, no. 6, pp. 595–612, Nov. 2022, doi: [10.1007/s11217-022-09842-8](https://doi.org/10.1007/s11217-022-09842-8).
- [30] X.-Q. Zhang, Q.-H. Gao, W. Tian, and T. Xin, “Dynamic and typological explanations of planning in complex problem-solving,” *Learning and Individual Differences*, vol. 110, p. 102417, Feb. 2024, doi: [10.1016/j.lindif.2024.102417](https://doi.org/10.1016/j.lindif.2024.102417).
- [31] W. Powell, “Effects of Place-Based Socioscientific Issues on Rising Middle School Students’ Evidence-Based Reasoning and Critical Thinking on Hydraulic Fracking,” *Journal of Education in Science, Environment and Health*, Jul. 2021, doi: [10.21891/jeseh.961002](https://doi.org/10.21891/jeseh.961002).
- [32] N. M. Siew and M. S. Abd Rahman, “EFFECTS OF SOCIO-SCIENTIFIC ISSUES BASED ON THINKING MAPS APPROACH ON FUTURE THINKING OF SECONDARY SCHOOL STUDENTS,” *JBSE*, vol. 21, no. 5, pp. 888–901, Oct. 2022, doi: [10.33225/jbse/22.21.888](https://doi.org/10.33225/jbse/22.21.888).
- [33] U. Betul Cebesoy and S.-N. Chang Rundgren, “Embracing socioscientific issues-based teaching and decision-making in teacher professional development,” *Educational Review*, vol. 75, no. 3, pp. 507–534, Apr. 2023, doi: [10.1080/00131911.2021.1931037](https://doi.org/10.1080/00131911.2021.1931037).
- [34] M. Palmer-Abbs, P. Deshpande, and C. W. Karl, “Enabling transition thinking on complex issues (wicked problems): A framework for future circular economic transitions of plastic management in the Norwegian fisheries and aquaculture sectors,” *Journal of Cleaner Production*, vol. 449, p. 141420, Apr. 2024, doi: [10.1016/j.jclepro.2024.141420](https://doi.org/10.1016/j.jclepro.2024.141420).

- [35] R. Manwaring, J. Holloway, and B. Coffey, “Engaging industry in curriculum design and delivery in public policy teaching: A strategic framework,” *Teaching Public Administration*, vol. 38, no. 1, pp. 46–62, Mar. 2020, doi: [10.1177/0144739419851155](https://doi.org/10.1177/0144739419851155).
- [36] J. M. Nevers, H. P. Eastman-Mueller, and S. B. Oswalt, “Ethical decision-making for sexuality educators: a new model,” *Sex Education*, vol. 23, no. 1, pp. 49–65, Jan. 2023, doi: [10.1080/14681811.2021.2020089](https://doi.org/10.1080/14681811.2021.2020089).
- [37] C. Lawrence, S. Jasanoff, S. W. Evans, K. Raffel, and L. Mahadevan, “Ethics Inside the Black Box: Integrating Science and Technology Studies into Engineering and Public Policy Curricula,” *Sci Eng Ethics*, vol. 29, no. 4, p. 23, Aug. 2023, doi: [10.1007/s11948-023-00440-6](https://doi.org/10.1007/s11948-023-00440-6).
- [38] N. S. Jessani *et al.*, “Evidence attack in public health: Diverse actors’ experiences with translating controversial or misrepresented evidence in health policy and systems research,” *Global Public Health*, vol. 17, no. 11, pp. 3043–3059, Nov. 2022, doi: [10.1080/17441692.2021.2020319](https://doi.org/10.1080/17441692.2021.2020319).
- [39] J. Terantino and K. Weinland, “Examining Social Studies Teachers’ Roles as Gatekeepers to”.
- [40] B. Nicolay *et al.*, “Examining the development of metacognitive strategy knowledge and its link to strategy application in complex problem solving – a longitudinal analysis,” *Metacognition Learning*, vol. 17, no. 3, pp. 837–854, Dec. 2022, doi: [10.1007/s11409-022-09324-9](https://doi.org/10.1007/s11409-022-09324-9).
- [41] L. Van Beek, N. Mouter, P. Pelzer, M. Hajer, and D. Van Vuuren, “Experts and expertise in practices of citizen engagement in climate policy: a comparative analysis of two contrasting cases,” *Climatic Change*, vol. 177, no. 1, p. 10, Jan. 2024, doi: [10.1007/s10584-023-03659-1](https://doi.org/10.1007/s10584-023-03659-1).
- [42] R. Li and G. Li, “EXPLORING LOWER-SECONDARY SCHOOL STUDENTS’ SYSTEMS THINKING PERFORMANCE IN ECOLOGICAL ISSUES,” *JBSE*, vol. 22, no. 5, pp. 865–880, Oct. 2023, doi: [10.33225/jbse/23.22.865](https://doi.org/10.33225/jbse/23.22.865).
- [43] C.-Y. Wang, S. Chen, and M.-Y. Huang, “Exploring medical students’ metacognitive and regulatory dimensions of diagnostic problem solving,” *Medical Education Online*, vol. 28, no. 1, p. 2210804, Dec. 2023, doi: [10.1080/10872981.2023.2210804](https://doi.org/10.1080/10872981.2023.2210804).
- [44] V. Simic, I. Gokasar, M. Deveci, and M. Isik, “Fermatean Fuzzy Group Decision-Making Based CODAS Approach for Taxation of Public Transit Investments,” *IEEE Trans. Eng. Manage.*, vol. 70, no. 12, pp. 4233–4248, Dec. 2023, doi: [10.1109/TEM.2021.3109038](https://doi.org/10.1109/TEM.2021.3109038).
- [45] Z. Scott, L. Lomičová, and J. Šerek, “How citizens evaluate the legitimacy of direct vote and representation-based decision-making: Findings from the focus groups on adoption of the Euro and acceptance of refugees,” *J. Soc. Polit. Psych.*, vol. 11, no. 1, pp. 408–423, Aug. 2023, doi: [10.5964/jspp.6895](https://doi.org/10.5964/jspp.6895).
- [46] D. Renninger, A. K. Reimers, I. Marzi, F. Beck, C. Krieger, and Y. Demetriou, “How do adolescents experience the decision-making process on travel mode choice?,” *Health Promotion International*, vol. 38, no. 6, p. daad147, Dec. 2023, doi: [10.1093/heapro/daad147](https://doi.org/10.1093/heapro/daad147).

- [47] S. Akerboom and R. K. Craig, “How law structures public participation in environmental decision making: A comparative law approach,” *Env Pol Gov*, vol. 32, no. 3, pp. 232–246, Jun. 2022, doi: [10.1002/eet.1986](https://doi.org/10.1002/eet.1986).
- [48] A. Cordova, J. Lahey, and L. Taghiyeva, “How to implement project-based quantitative classroom projects while supporting curricular design: A case study from a quantitative methods course in a public affairs program,” *Teaching Public Administration*, vol. 41, no. 2, pp. 284–299, Jul. 2023, doi: [10.1177/01447394221079692](https://doi.org/10.1177/01447394221079692).
- [49] T. Araujo, A. Brosius, A. C. Goldberg, and J. Möller, “Humans vs. AI: The Role of Trust, Political Attitudes, and Individual Characteristics on Perceptions about Automated Decision Making Across Europe,” 2023.
- [50] B. Alaybek, R. S. Dalal, and B. Dade, “Individual Differences in Judgment and Decision-Making: Novel Predictors of Counterproductive Work Behavior,” *J Bus Psychol*, vol. 38, no. 5, pp. 1043–1059, Oct. 2023, doi: [10.1007/s10869-022-09843-x](https://doi.org/10.1007/s10869-022-09843-x).
- [51] J. Roddy, “Integrating economics into professional studies: Criminal justice, health, and public policy education,” *The Journal of Economic Education*, vol. 53, no. 2, pp. 159–164, Mar. 2022, doi: [10.1080/00220485.2022.2038325](https://doi.org/10.1080/00220485.2022.2038325).
- [52] T. M. Schwartz-Tayri, M. Malka, M. Moshe-Grodofsky, and N. Gilbert, “Integrating Micro and Macro Practice: An Evaluation of the Policy Advocacy Course,” *Journal of Social Work Education*, vol. 57, no. 3, pp. 464–477, Jul. 2021, doi: [10.1080/10437797.2020.1713271](https://doi.org/10.1080/10437797.2020.1713271).
- [53] F. Krieger, R. Azevedo, A. C. Graesser, and S. Greiff, “Introduction to the special issue: the role of metacognition in complex skills - spotlights on problem solving, collaboration, and self-regulated learning,” *Metacognition Learning*, vol. 17, no. 3, pp. 683–690, Dec. 2022, doi: [10.1007/s11409-022-09327-6](https://doi.org/10.1007/s11409-022-09327-6).
- [54] L. Morales, “Judicial interventions in health policy: Epistemic competence and the courts,” *Bioethics*, vol. 35, no. 8, pp. 760–766, Oct. 2021, doi: [10.1111/bioe.12904](https://doi.org/10.1111/bioe.12904).
- [55] E. Levy Yeyati, L. Moscovich, and C. Abuin, “Leader over Policy? The Scope of Elite Influence on Policy Preferences,” *Political Communication*, vol. 37, no. 3, pp. 398–422, May 2020, doi: [10.1080/10584609.2019.1698681](https://doi.org/10.1080/10584609.2019.1698681).
- [56] H. Wu and G. Molnár, “Logfile analyses of successful and unsuccessful strategy use in complex problem-solving: a cross-national comparison study,” *Eur J Psychol Educ*, vol. 36, no. 4, pp. 1009–1032, Dec. 2021, doi: [10.1007/s10212-020-00516-y](https://doi.org/10.1007/s10212-020-00516-y).
- [57] L. D. A. Almeida and R. C. Gomes, “MAIP: model to identify actors’ influence and its effects on the complex environmental policy decision-making process,” *Environmental Science & Policy*, vol. 112, pp. 69–78, Oct. 2020, doi: [10.1016/j.envsci.2020.04.016](https://doi.org/10.1016/j.envsci.2020.04.016).
- [58] E. Cerracchio, S. Miletić, and B. U. Forstmann, “Modelling decision-making biases,” *Front. Comput. Neurosci.*, vol. 17, p. 1222924, Oct. 2023, doi: [10.3389/fncom.2023.1222924](https://doi.org/10.3389/fncom.2023.1222924).

- [59] S. B. Amor, F. Belaid, R. Benkraiem, B. Ramdani, and K. Guesmi, “Multi-criteria classification, sorting, and clustering: a bibliometric review and research agenda,” *Ann Oper Res*, vol. 325, no. 2, pp. 771–793, Jun. 2023, doi: [10.1007/s10479-022-04986-9](https://doi.org/10.1007/s10479-022-04986-9).
- [60] C. Baird and D. Mayer, “On integrative social contracts theory and corporate decision-making in a polarized political economy,” *Business and Society Review*, vol. 126, no. 1, pp. 3–23, Mar. 2021, doi: [10.1111/basr.12223](https://doi.org/10.1111/basr.12223).
- [61] N. Takahashi, “On the ‘yarisugoshi’ phenomenon found in the situation where ‘decision making by flight’ of the garbage can model occurs,” *ABAS*, vol. 22, no. 5, pp. 59–74, Oct. 2023, doi: [10.7880/abas.0230810a](https://doi.org/10.7880/abas.0230810a).
- [62] A. Malkamäki, P. M. Wagner, M. Brockhaus, A. Toppinen, and T. Ylä-Anttila, “On the Acoustics of Policy Learning: Can Co-Participation in Policy Forums Break Up Echo Chambers?,” *Policy Studies Journal*, vol. 49, no. 2, pp. 431–456, May 2021, doi: [10.1111/psj.12378](https://doi.org/10.1111/psj.12378).
- [63] M. G. Wilson, S. Oliver, G. J. Melendez-Torres, J. N. Lavis, K. Waddell, and K. Dickson, “Paper 3: Selecting rapid review methods for complex questions related to health policy and system issues,” *Syst Rev*, vol. 10, no. 1, p. 286, Dec. 2021, doi: [10.1186/s13643-021-01834-y](https://doi.org/10.1186/s13643-021-01834-y).
- [64] N. Brophy and K. J. Mullinix, “Partisan Motivated Empathy and Policy Attitudes,” *Polit Behav*, Aug. 2023, doi: [10.1007/s11109-023-09890-x](https://doi.org/10.1007/s11109-023-09890-x).
- [65] G. Andreottola and C. Li, “Polarization and Policy Design,” *Journal of Political Economy Microeconomics*, vol. 2, no. 1, pp. 1–42, Feb. 2024, doi: [10.1086/726844](https://doi.org/10.1086/726844).
- [66] K. Hara *et al.*, “Policy design by ‘imaginary future generations’ with systems thinking : a practice by Kyoto city towards decarbonization in 2050,” *Futures*, vol. 154, p. 103272, Dec. 2023, doi: [10.1016/j.futures.2023.103272](https://doi.org/10.1016/j.futures.2023.103272).
- [67] Í. Santos and E. Pekkola, “Policy entrepreneurs in the global education complex: The case of Finnish education experts working in international organisations,” *International Journal of Educational Development*, vol. 98, p. 102749, Apr. 2023, doi: [10.1016/j.ijedudev.2023.102749](https://doi.org/10.1016/j.ijedudev.2023.102749).
- [68] C. M. Radaelli, “Policy Learning and European Integration,” *J of Common Market Studies*, vol. 60, no. S1, pp. 12–25, Sep. 2022, doi: [10.1111/jcms.13432](https://doi.org/10.1111/jcms.13432).
- [69] M. C. Nowlin, “Policy Learning and Information Processing,” *Policy Studies Journal*, vol. 49, no. 4, pp. 1019–1039, Nov. 2021, doi: [10.1111/psj.12397](https://doi.org/10.1111/psj.12397).
- [70] C. Kim and K. Y. Nam, “Policy Puzzle Game: making policy ideas feasible and acceptable in policy co-design,” *CoDesign*, vol. 18, no. 4, pp. 448–465, Oct. 2022, doi: [10.1080/15710882.2021.1995440](https://doi.org/10.1080/15710882.2021.1995440).
- [71] I. Alkaher and N. Carmi, “Population growth as the elephant in the room: teachers’ perspectives and willingness to incorporate a controversial environmental sustainability issue in their teaching,” *Environmental Education Research*, pp. 1–28, Jan. 2024, doi: [10.1080/13504622.2023.2296358](https://doi.org/10.1080/13504622.2023.2296358).

- [72] F. Petersen, “Pragmatist democracy and the populist challenge,” *Philosophy & Social Criticism*, vol. 48, no. 10, pp. 1427–1444, Dec. 2022, doi: [10.1177/01914537221114917](https://doi.org/10.1177/01914537221114917).
- [73] B. Fang, “Probabilistic linguistic decision-making based on the hybrid entropy and cross-entropy measures,” *Fuzzy Optim Decis Making*, vol. 22, no. 3, pp. 415–445, Sep. 2023, doi: [10.1007/s10700-022-09398-9](https://doi.org/10.1007/s10700-022-09398-9).
- [74] D. H. Santi, B. A. Prayitno, and M. Muzzazinah, “Problem solving process and creative thinking of students in ecosystem issue,” *JPBI*, vol. 5, no. 3, pp. 537–548, Nov. 2019, doi: [10.22219/jpbi.v5i3.9647](https://doi.org/10.22219/jpbi.v5i3.9647).
- [75] J. C. Sanabria-Zepeda, P. G. Olivo-Montaña, I. Artemova, and A. J. Argüelles-Cruz, “Prospective narratives on global issues: An AI-based pedagogical model for assessing complex thinking,” *J. Technol. Sci. Educ.*, vol. 14, no. 1, p. 184, Jan. 2024, doi: [10.3926/jotse.2445](https://doi.org/10.3926/jotse.2445).
- [76] O. G. El-Taliawi, S. Nair, and Z. Van Der Wal, “Public policy schools in the global south: a mapping and analysis of the emerging landscape,” *Policy Sci*, vol. 54, no. 2, pp. 371–395, Jun. 2021, doi: [10.1007/s11077-020-09413-z](https://doi.org/10.1007/s11077-020-09413-z).
- [77] W. Tao, C. Hong, W.-H. S. Tsai, and B. Yook, “Publics’ communication on controversial sociopolitical issues: extending the situational theory of problem solving,” *Journal of Applied Communication Research*, vol. 49, no. 1, pp. 44–65, Jan. 2021, doi: [10.1080/00909882.2020.1849770](https://doi.org/10.1080/00909882.2020.1849770).
- [78] R. M. Walker, J. Zhang, and E. W. Cheng, “Puncturing the Knowledge Illusion Does Not Reduce Policy and Political Extremism: Evidence From a Replication and Extension,” *Political Psychology*, p. pops.12938, Oct. 2023, doi: [10.1111/pops.12938](https://doi.org/10.1111/pops.12938).
- [79] H. Pitlik and M. Rode, “Radical Distrust: Are Economic Policy Attitudes Tempered by Social Trust?,” *Soc Indic Res*, vol. 158, no. 2, pp. 485–506, Dec. 2021, doi: [10.1007/s11205-020-02317-8](https://doi.org/10.1007/s11205-020-02317-8).
- [80] Z. Austin and A. Háji, “Regulation of Wicked Problems: Opportunities, Responsibilities, and Threats,” *Journal of Medical Regulation*, vol. 109, no. 3, pp. 6–11, Nov. 2023, doi: [10.30770/2572-1852-109.3.6](https://doi.org/10.30770/2572-1852-109.3.6).
- [81] A. Bocse, “Relational Power, Brokers and Influence: A Study on the Controversial Issue of Fracking in the European Union,” *J of Common Market Studies*, vol. 59, no. 5, pp. 1267–1283, Sep. 2021, doi: [10.1111/jcms.13196](https://doi.org/10.1111/jcms.13196).
- [82] R. V. D. Maten, E. C. Carballo-Cárdenas, and J. Van Tatenhove, “Resistance to change: A case study on framing and policy change of a controversial nature area,” *E&S*, vol. 27, no. 1, p. art29, 2022, doi: [10.5751/ES-12955-270129](https://doi.org/10.5751/ES-12955-270129).
- [83] A. Roberts, “Risk, Reward, and Resilience Framework: Integrative Policy Making in a Complex World,” *Journal of International Economic Law*, vol. 26, no. 2, pp. 233–265, May 2023, doi: [10.1093/jiel/jgad009](https://doi.org/10.1093/jiel/jgad009).

- [84] A. J. He, Y. Fan, and R. Su, "Seeking policy solutions in a complex system: experimentalist governance in China's healthcare reform," *Policy Sci*, vol. 55, no. 4, pp. 755–776, Dec. 2022, doi: [10.1007/s11077-022-09482-2](https://doi.org/10.1007/s11077-022-09482-2).
- [85] M. E. Nyström, S. Tolf, and H. Strehlenert, "Sense-Making, Mutual Learning and Cognitive Shifts When Applying Systems Thinking in Public Health – Examples From Sweden Comment on "What Can Policy-Makers Get Out of Systems Thinking? Policy Partners' Experiences of a Systems-Focused Research Collaboration in Preventive Health"," *Int J Health Policy Manag*, p. 1, Jul. 2020, doi: [10.34172/ijhpm.2020.106](https://doi.org/10.34172/ijhpm.2020.106).
- [86] A. Karimo *et al.*, "Shared Positions on Divisive Beliefs Explain Interorganizational Collaboration: Evidence from Climate Change Policy Subsystems in 11 Countries," *Journal of Public Administration Research and Theory*, vol. 33, no. 3, pp. 421–433, Jun. 2023, doi: [10.1093/jopart/muac031](https://doi.org/10.1093/jopart/muac031).
- [87] M. Salehin, "Socio-political and economic correlates influencing abortion policies across the states in America".
- [88] N. Balasubramanian, Y. Ye, and M. Xu, "Substituting Human Decision-Making with Machine Learning: Implications for Organizational Learning," *AMR*, vol. 47, no. 3, pp. 448–465, Jul. 2022, doi: [10.5465/amr.2019.0470](https://doi.org/10.5465/amr.2019.0470).
- [89] S. Goodman and A. Locke, "Supporting and challenging hate in an online discussion of a controversial refugee policy," *Discourse Studies*, p. 14614456231225448, Feb. 2024, doi: [10.1177/14614456231225448](https://doi.org/10.1177/14614456231225448).
- [90] C. V. Castro, "Systems-thinking for environmental policy coherence: Stakeholder knowledge, fuzzy logic, and causal reasoning," *Environmental Science & Policy*, vol. 136, pp. 413–427, Oct. 2022, doi: [10.1016/j.envsci.2022.07.001](https://doi.org/10.1016/j.envsci.2022.07.001).
- [91] A. Flores, D. Boden, D. Haider-Markel, D. Lewis, P. Miller, and J. Taylor, "Taking perspective of the stories we tell about transgender rights: The narrative policy framework," *Policy Studies Journal*, vol. 51, no. 1, pp. 123–143, Feb. 2023, doi: [10.1111/psj.12475](https://doi.org/10.1111/psj.12475).
- [92] L. Tower, M. Mankowski, K. Hash, and H. Kim, "Teach-In: Positive Responses during Divisive Times," *Journal of Teaching in Social Work*, vol. 39, no. 3, pp. 237–247, May 2019, doi: [10.1080/08841233.2019.1607798](https://doi.org/10.1080/08841233.2019.1607798).
- [93] L. Jerome and A. Elwick, "Teaching about terrorism, extremism and radicalisation: some implications for controversial issues pedagogy," *Oxford Review of Education*, vol. 46, no. 2, pp. 222–237, Mar. 2020, doi: [10.1080/03054985.2019.1667318](https://doi.org/10.1080/03054985.2019.1667318).
- [94] H. Seckinelgin, "Teaching social policy as if students matter: Decolonizing the curriculum and perpetuating epistemic injustice," *Critical Social Policy*, vol. 43, no. 2, pp. 296–315, May 2023, doi: [10.1177/02610183221103745](https://doi.org/10.1177/02610183221103745).

- [95] A. P. Durnová and C. M. Weible, “Tempest in a teapot? Toward new collaborations between mainstream policy process studies and interpretive policy studies,” *Policy Sci*, vol. 53, no. 3, pp. 571–588, Sep. 2020, doi: [10.1007/s11077-020-09387-y](https://doi.org/10.1007/s11077-020-09387-y).
- [96] S. Mihelj, K. Kondor, V. Štětka, and F. Tóth, “The ambivalences of visibility: News consumption and public attitudes to same-sex relationships in the context of illiberalism,” *European Journal of Communication*, vol. 38, no. 6, pp. 571–590, Dec. 2023, doi: [10.1177/02673231221150347](https://doi.org/10.1177/02673231221150347).
- [97] T. Baker, B. T. O. PublicEmployees, C. InstructionalSpeech, A. U. Freedom, and B. UnderminseEstablished, “THE CLASSROOM BULLY PULPIT: DIVISIVE CONCEPTS LAWS ARE UNDERMINING INSTRUCTIONAL FREE SPEECH,” vol. 29.
- [98] V. F. Kalsås and J. Helakorpi, “The curriculum as a controversial issue: Negotiations about the position of Norwegian Romani in education and society,” *ADNO*, vol. 14, no. 4, Dec. 2020, doi: [10.5617/adno.8378](https://doi.org/10.5617/adno.8378).
- [99] F. Şaşmazören, A. Karapinar, K. Sari, and T. DemiRer, “The Effect of Using Scientific Scenarios in Teaching Socioscientific Issues in Science Course on Students’ Logical Thinking Skills,” *Kuramsal Eğitimbilim*, vol. 15, no. 2, pp. 420–452, Apr. 2022, doi: [10.30831/akukeg.1001361](https://doi.org/10.30831/akukeg.1001361).
- [100] M.-J. Chen, H.-C. She, and P.-Y. Tsai, “The effects of online simulation-based collaborative problem-solving on students’ problem-solving, communication and collaboration attitudes,” *Educ Inf Technol*, Mar. 2024, doi: [10.1007/s10639-024-12609-y](https://doi.org/10.1007/s10639-024-12609-y).
- [101] M. Skiba, M. Mrówczyńska, M. Sztubecka, A. Maciejko, and N. Rzeszowska, “The European Union’s Energy Policy Efforts Regarding Emission Reduction in Cities—A Method Proposal,” *Energies*, vol. 16, no. 17, p. 6123, Aug. 2023, doi: [10.3390/en16176123](https://doi.org/10.3390/en16176123).
- [102] D. M. S. Dissanayake and A. K. L. Jayawardana, “The impact of personal sense of power on unethical decision-making: a moderated mediation model of love of money motive and power distance orientation,” *Decision*, vol. 50, no. 1, pp. 19–34, Mar. 2023, doi: [10.1007/s40622-023-00340-5](https://doi.org/10.1007/s40622-023-00340-5).
- [103] C. Lescarret, V. Le Floch, J.-C. Sakdavong, J.-M. Boucheix, A. Tricot, and F. Amadieu, “The impact of students’ prior attitude on the processing of conflicting videos: a comparison between middle-school and undergraduate students,” *Eur J Psychol Educ*, vol. 38, no. 2, pp. 519–544, Jun. 2023, doi: [10.1007/s10212-022-00634-9](https://doi.org/10.1007/s10212-022-00634-9).
- [104] X. Liu, J. Gu, and J. Xu, “The impact of the design thinking model on pre-service teachers’ creativity self-efficacy, inventive problem-solving skills, and technology-related motivation,” *Int J Technol Des Educ*, vol. 34, no. 1, pp. 167–190, Mar. 2024, doi: [10.1007/s10798-023-09809-x](https://doi.org/10.1007/s10798-023-09809-x).
- [105] J. W. Campbell, S. K. Pandey, and L. Arnesen, “The ontology, origin, and impact of divisive public sector rules: A META - NARRATIVE review of the red tape and administrative burden literatures,” *Public Administration Review*, vol. 83, no. 2, pp. 296–315, Mar. 2023, doi: [10.1111/puar.13527](https://doi.org/10.1111/puar.13527).

- [106] D. Beach, D. Schäfer, and S. Smeets, “The Past in the Present—The Role of Analogical Reasoning in Epistemic Learning About How to Tackle Complex Policy Problems,” *Policy Studies Journal*, vol. 49, no. 2, pp. 457–483, May 2021, doi: [10.1111/psj.12372](https://doi.org/10.1111/psj.12372).
- [107] H. Hariyanto, S. R. Hikamah, N. H. Maghfiroh, and E. Priawasana, “The potential of the discovery learning model integrated the reading, questioning, and answering model on cross-cultural high school students’ problem-solving skills,” *EduLearn*, vol. 17, no. 1, pp. 58–66, Feb. 2023, doi: [10.11591/edulearn.v17i1.20599](https://doi.org/10.11591/edulearn.v17i1.20599).
- [108] N. Munoz-del-Campo, “The problem-based learning as a pedagogical framework for teaching master of public policy and master of public administration programs in Latin America,” *Teaching Public Administration*, vol. 41, no. 3, pp. 408–426, Oct. 2023, doi: [10.1177/01447394221124818](https://doi.org/10.1177/01447394221124818).
- [109] J. S. Chen, D. W. Elfenbein, H. E. Posen, and M. Z. Wang, “The Problems and Promise of Entrepreneurial Partnerships: Decision-Making, Overconfidence, and Learning in Founding Teams,” *AMR*, vol. 47, no. 3, pp. 489–520, Jul. 2022, doi: [10.5465/amr.2019.0119](https://doi.org/10.5465/amr.2019.0119).
- [110] Y. Kammerer, S. Gottschling, and I. Bråten, “The Role of Internet-Specific Justification Beliefs in Source Evaluation and Corroboration During Web Search on an Unsettled Socio-Scientific Issue,” *Journal of Educational Computing Research*, vol. 59, no. 2, pp. 342–378, Apr. 2021, doi: [10.1177/0735633120952731](https://doi.org/10.1177/0735633120952731).
- [111] W. Herrmann, J. F. Beckmann, and A. Kretzschmar, “The role of learning in complex problem solving using MicroDYN,” *Intelligence*, vol. 100, p. 101773, Sep. 2023, doi: [10.1016/j.intell.2023.101773](https://doi.org/10.1016/j.intell.2023.101773).
- [112] B. Wahono, E. Narulita, C.-Y. Chang, E. Darmawan, and I. Irwanto, “The Role of Students’ Worldview on Decision-Making: An Indonesian Case Study by a Socio-Scientific Issue-Based Instruction Through Integrated STEM Education,” *EURASIA J Math Sci Tech Ed*, vol. 17, no. 11, p. em2027, Oct. 2021, doi: [10.29333/ejmste/11246](https://doi.org/10.29333/ejmste/11246).
- [113] L. Caroleo, G. Giorgi, and C. De Amicis, “The SEO effect. Mapping the optimized landscape around controversial policy issues in Italy,” *Front. Sociol.*, vol. 8, p. 1144669, Feb. 2023, doi: [10.3389/fsoc.2023.1144669](https://doi.org/10.3389/fsoc.2023.1144669).
- [114] E. M. Polo, A. Farabbi, M. Mollura, L. Mainardi, and R. Barbieri, “Understanding the role of emotion in decision making process: using machine learning to analyze physiological responses to visual, auditory, and combined stimulation,” *Front. Hum. Neurosci.*, vol. 17, p. 1286621, Jan. 2024, doi: [10.3389/fnhum.2023.1286621](https://doi.org/10.3389/fnhum.2023.1286621).
- [115] G. Molnár and S. Greiff, “Understanding transitions in complex problem-solving: Why we succeed and where we fail,” *Thinking Skills and Creativity*, vol. 50, p. 101408, Dec. 2023, doi: [10.1016/j.tsc.2023.101408](https://doi.org/10.1016/j.tsc.2023.101408).
- [116] S. Zarb and K. Taylor, “Uneven local implementation of federal policy after disaster: Policy conflict and goal ambiguity,” *Review of Policy Research*, vol. 40, no. 1, pp. 63–87, Jan. 2023, doi: [10.1111/ropr.12478](https://doi.org/10.1111/ropr.12478).

- [117] B. Nicolay *et al.*, “Unsuccessful and successful complex problem solvers – A log file analysis of complex problem solving strategies across multiple tasks,” *Intelligence*, vol. 101, p. 101793, Nov. 2023, doi: [10.1016/j.intell.2023.101793](https://doi.org/10.1016/j.intell.2023.101793).
- [118] J. H. Nieminen, M. C. E. Chan, and D. Clarke, “What affordances do open-ended real-life tasks offer for sharing student agency in collaborative problem-solving?,” *Educ Stud Math*, vol. 109, no. 1, pp. 115–136, Jan. 2022, doi: [10.1007/s10649-021-10074-9](https://doi.org/10.1007/s10649-021-10074-9).
- [119] A. Junqueira, A. Kagalwala, and C. S. Lipsmeyer, “What’s your problem? How issue ownership and partisan discourse influence personal concerns,” *Social Science Quarterly*, vol. 104, no. 1, pp. 25–37, Jan. 2023, doi: [10.1111/ssqu.13259](https://doi.org/10.1111/ssqu.13259).
- [120] D. Arli, P. Van Esch, and Y. Cui, “Who Cares More About the Environment, Those with an Intrinsic, an Extrinsic, a Quest, or an Atheistic Religious Orientation?: Investigating the Effect of Religious Ad Appeals on Attitudes Toward the Environment,” *J Bus Ethics*, vol. 185, no. 2, pp. 427–448, Jun. 2023, doi: [10.1007/s10551-022-05164-4](https://doi.org/10.1007/s10551-022-05164-4).
- [121] O. R. Young and O. S. Stokke, “Why is it hard to solve environmental problems? The perils of institutional reductionism and institutional overload,” *Int Environ Agreements*, vol. 20, no. 1, pp. 5–19, Mar. 2020, doi: [10.1007/s10784-020-09468-6](https://doi.org/10.1007/s10784-020-09468-6).
- [122] N. D. Arney and H. P. Krygsman, “Work-Integrated Learning Policy in Alberta: A Post-Structural Analysis”.
- [123] A. D. Ross and S. M. Rouse, “(Young) Generations as Social Identities: The Role of Latino*Millennial/Generation Z in Shaping Attitudes About Climate Change,” *Polit Behav*, vol. 44, no. 3, pp. 1105–1124, Sep. 2022, doi: [10.1007/s11109-020-09649-8](https://doi.org/10.1007/s11109-020-09649-8).

Appendix B: Public Search Results by Title

Selected Public Search Result Titles by Term (Web Pages)					
Thinking AND Policy	Complex AND Policy	Decision-Making AND Policy	Divisive AND Policy	Divisive AND Decision-Making	Problem Solving AND Complex
OECD Systemic Thinking for Policy Making	OSF What makes policy complex?	The Open University 1.3 Decision making and policy making OpenLearn	Free Speech Center - Divisive Concepts - The Free Speech Center - MTSU	Project Management - Are You a Decisive or Divisive Decision Maker?	SoftwareDominos The 7 Timeless Steps to Guide You Through Complex Problem Solving
CDC Thinking in Systems Overview POLARIS Policy	Cambridge University Press & Assessment What makes policy complex? Political Science Research and Methods	Pan American Health Organization (PAHO) Policy Analysis and Decision-Making Key Points	Volunteer State Community College - Divisive Concepts and Freedom of Expression	University of Michigan Library - The Polythink Syndrome and Elite Group Decision-Making	Indeed Complex Problem-Solving: Definition and Steps
Systemic Thinking for Policy Making : The Potential of Systems Analysis for Addressing Global Policy Challenges in the 21st Century	GOV UK Blogs It's complex, not complicated - Public Policy Design	AI Chat for Scientific PDFs How is Decision Making different from policy making?	Pew Research Center - Section 4: Political Compromise and Divisive Policy Debates	Project Management - Decisive, Not Divisive	National Institutes of Health (NIH) Complex Problem Solving: What It Is and What It Is Not-PMC
Systems thinking for policymaking GOV.UK blogs	Jstor Eliciting Public Values for Complex Policy Decisions	Quora What is policy and decision making? What are their relations?	National Coalition for History Divisive Concepts Legislation	National Institutes of Health - Understanding the Hows and Whys of Decision-Making	Linkedin-Overlap Associates An Introduction to Complex Problem Solving
MDPI Implementation of Systems Thinking in Public Policy: A Systematic Review	RAND Policy Analysis for Complex Systems	Nonprofit Accounting Basics Decision Making Policy Example	University of Tennessee, Knoxville - Divisive Concepts Legislation: Information and Support	Wiley Online Library - The Polythink Syndrome and Elite Group Decision-Making	Bryan Lindsley How to Solve Complex Problems
What Can Policy-Makers Get Out of Systems Thinking? Policy Partners' Experiences of a Systems-Focused Research Collaboration in Preventive Health	ResearchGate Policy Integration for Complex Policy Problems: What, why and how	Springer Policy and Decision Making	MTSU - Tennessee Divisive Concepts Act	Medium - How decision-making affects our behavior by Ted Rau	Medium - Tom Hogarth Complex vs Complicated: Which problem are you solving?
Policy Thinking: The art of Policymaking	Bristol University Press Digital What types of health evidence persuade policy actors in a complex system?	Differencebetween Difference Between Policy Making and Decision Making	Education Week - What Is Critical Race Theory, and Why Is It Under Attack?	SSRN eLibrary - The Polythink Syndrome and Elite Group Decision-Making	Springer Complex Problem Solving
COV.UK Launching "Systemic" - A game for applying systems change thinking to policy	Crawford School of Public Policy Adaptive thinking for complex policy development	Jstor Decision Making vs. Policy Making: Toward and Antidote for Technocracy	The University of Memphis - Divisive Concepts Act - Academic Affairs	The Practical Decision Maker A Handbook for Decision Making and Problem Solving By Thomas R. Harvey, Sharon M. Corkrum, Shari L. Fox · 2022	LinkedIn How do you solve a complex problem? Critical Thinking
	LinkedIn How to communicate complex policy issues clearly	Encyclopedia Public Policy Decision Making	Tennessee State University - Divisive Concepts Act	It's Your Decision A Commonsense Guide to Making Better Choices By Al Foderaro, Denise Schmidt · 2008	SessionsLab 35 problem-solving techniques and methods for solving complex problems
	LSE Blogs Public Policy - a science and an art in an increasingly complex world	TechTarget What is the decision-making process?			IDEO U Creative Thinking for Complex Problem Solving

Table B1: Titles of Web Pages Reviewed by Search Term

Selected Public Search Result Titles by Term (Books)					
Thinking AND Policy	Complex AND Policy	Decision-Making AND Policy	Divisive AND Policy	Divisive AND Decision-Making	Problem Solving AND Complex
Application of Systems Thinking to health policy and public health ethics. public health and private illness Michele Battle-Fisher · 2014	Systems Science for Complex Policy Making: A Study of Indonesia - Kuntoro Mangkusubroto, Utomo Sarjono Putro, Santi Novani (2016)	Environmental Health Risks and Public Policy: Decision Making in Free Societies – David Bates (1994)	The Divisive State of Social Policy The 'Bedroom Tax', Austerity and Housing Insecurity By Kelly Bogue · 2019	Selection of Decision-Making Models in Intergovernmental Organizations: A Poliheuristic Approach to Political Regime Type Influence By Timothy Tamutana Tamunang · 2021	Complex Problem Solving: The European Perspective - Peter Frensch, Joachim Funke, 2014
Thinking about Public Policy: A Problem-solving Approach (1983) By Melvin J. Dubnick, Barbara A. Bardes	Policy Practice and Digital Science: Integrating Complex Systems, Social Simulation and Public Administration in Policy Research (Marijn Janssen, Maria A. Wimmer, Ameneh Deljoo) (2015)	Foreign Policy Decision Making: The Influence of Cognition – Martha Cottam (2019)	Divisive Discourse: The Extreme Rhetoric of Contemporary American Politics (Second Edition) By Joseph Zompetti · 2017		Strategic Thinking in Complex Problem Solving-Amaud Chevallier, 2016
Systems thinking analysis for health policy and system development. A Malaysian case study Jo. M. Martins, Indra Pathmanathan, David T. Tan · 2021	Complex Policy Planning: The Government Strategic Management of the Social Care Market - Philip Haynes (2018)	Making Foreign Policy: Presidential Management of the Decision-making Process David Mitchell (2005)			Complex Problem Solving: Principles and Mechanisms - Robert Sternberg, Peter Frensch, 2014
Systems Thinking for health systems and Strengthening Don De Savigny, Taghreed Adam, Alliance for Health Policy and Systems Research · 2009	Making Policy in a Complex World - Paul Cairney, Tanya Heikkila, Matthew Wood (2019)	Foreign Policy Decision-Making (Revisited) - R. Snyder, H. Bruck, B. Sapin (2003)			Solving Complex Problems: Professional Group Decision-making-Alexander de Haan, Pauline de Heer, 2015
Magical thinking in public policy John Boswell · 2023	Race, Poverty, and the Cities: Hyperinnovation in Complex Policy Systems - Madeline Landau (1988)	Decision-Making in American Foreign Policy: Translating Theory Into Practice - Nikolas K. Gvosdev, Jessica D. Blankshain, David A. Cooper (2019)			Interaction Design for Complex Problem Solving-Barbara Mirel, 2004
history, policy, and public purpose Historians and historical thinking in government Alix R.Green 2016	Complexity and Public Policy: A New Approach to 21st Century politics, policy and society - Robert Geyer, Samir Rihani (2012)	Understanding Foreign Policy Decision Making - Alex Mintz, Karl DeRouen Jr (2010)			What if? Building Students' Problem-Solving Skills Through Complex Challenges - Ronald Beghetto, 2018
	Evaluating the Complex: Attribution, Contribution, and Beyond - Kim Forss, Mita Marra, Robert Schwartz (2011)	"Presidential Decision Making: The Economic Policy Board - Roger B Porter (1982)"			Bulletproof Problem Solving: The One Skill That Changes Everything-Charles Conn, Robert McLean, 2019
					Problem Solving 101: A Simple Book for Smart People - Ken Watanabe, 2009

Table B2: Titles of Books Reviewed by Search Term

Appendix C: “Solving Problems” Surveys

Statement of Consent:

1. I have read the information above and consent to take part in this study.
 - a. Yes
 - b. No

Scenario: “In a small town, there's a growing problem - too much plastic waste is piling up. The town's leaders can't agree on a good plan to deal with it. They want you to look into the problem, summarize it, and suggest some practical ways to fix it.”

2. Do you understand your role in the presented scenario?
 - a. Yes
 - b. No
3. How would you rate your ability to solve problems?
 - a. Low Ability
 - b. Moderate Ability
 - c. High Ability
4. To what extent is plastic waste an issue that you have previously taken an interest in?
 - a. Not at all
 - b. Somewhat of an interest
 - c. High Interest
5. On a scale of 1-10, ten being the highest, as the town consultant, how confident are you in your ability to assess the town's plastic waste concerns presented in the scenario?
 - a. 1-10 scale
6. In your own words, please describe how you would assess the town's plastic waste concerns.
 - a. [Short answer response box]
7. Please watch the following short video before answering any more questions.
 - a. [Presented with 1 of 5 videos. Required to stay on page for the entire video.]
8. Now that you have watched the video and learned this thinking tool, on a scale of 1-10, ten being the highest, how confident are you in your ability to assess the town's plastic waste concerns presented in the scenario?
 - a. 1-10 scale
9. Using the thinking tool you learned in the video, please describe how you would assess the town's plastic waste concerns.
 - a. [Short answer response box]
10. To what degree do you think your second assessment (after watching the video) is better than the first?
 - a. Not at all better
 - b. Slightly better
 - c. Moderately better
 - d. Significantly better
11. How likely are you to apply the thinking tool you learned in the video to other situations that may arise in your own life?
 - a. Not at all likely
 - b. Somewhat likely
 - c. Extremely likely
12. What is the highest degree or level of education you have completed?
 - a. Advanced Degree (Master's, Ph.D., M.D.)
 - b. Associate degree
 - c. Bachelor's degree
 - d. Graduated high school

- e. Some college, no degree
 - f. Trade/technical school
13. What gender do you identify as?
- a. Male
 - b. Female
 - c. Other - Write In:
14. What is your age?
- a. 18 to 24
 - b. 25 to 34
 - c. 35 to 44
 - d. 45 to 54
 - e. 55 to 64
 - f. 65 to 74
 - g. 75 or older
15. Please specify your race & ethnicity (check all that apply).
- a. Asian
 - b. Native Hawaiian or Other Pacific Islander
 - c. Black/African-American
 - d. White
 - e. Hispanic/Latino
 - f. American Indian/Alaska Native
 - g. Other - Write In
 - h. Prefer not to answer
 - i. Other - Write In
16. Generally speaking, do you think of yourself as a Democrat, Republican, Independent or something else?
- a. Democrat
 - b. Republican
 - c. Independent
 - d. Something else
17. How would you characterize your political stance?
- a. Conservative
 - b. Extremely Conservative
 - c. Liberal
 - d. Extremely Liberal
 - e. Moderate

Appendix D: Video Interventions

All videos followed the same format, which included a whiteboard recording depicting the move with a faceless narration and closed captioning. Each started with the same introduction broadly explaining structures for improving our thinking. Transcripts of each video with select screenshots follow below.

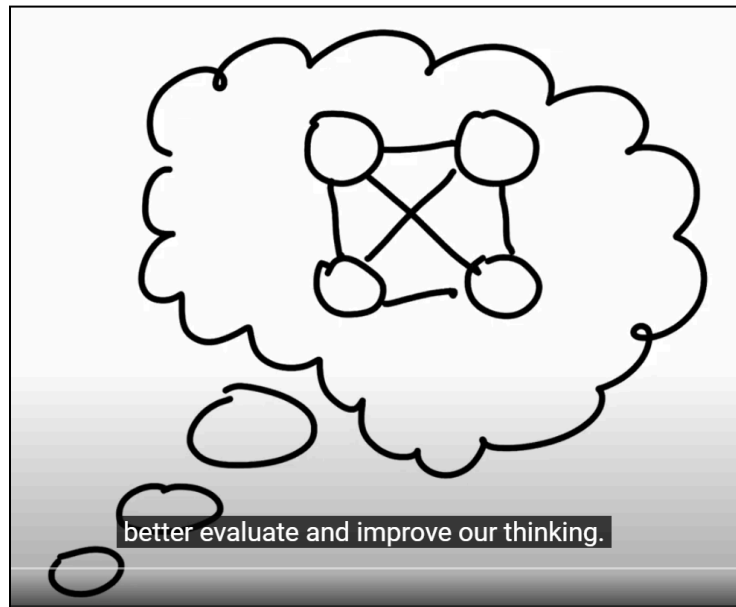


Figure D1: Screenshot from Introductory Statement

P-Circles

When we think, we create meaning by structuring information from the world around us. Visualizing these structures helps us better evaluate and improve our thinking.

One way we structure our thinking is by gathering perspectives. When we think about an object, idea, or issue, we can consider multiple perspectives.

For example, say a school is considering requiring uniforms. Students might view uniforms one way, while teachers or parents might view them another.

Perspectives extend beyond individuals, too. We might examine the uniforms from the perspective of affordability, color, or fashion.

By gathering a circle of perspectives, we can better understand any object, idea, or issue.

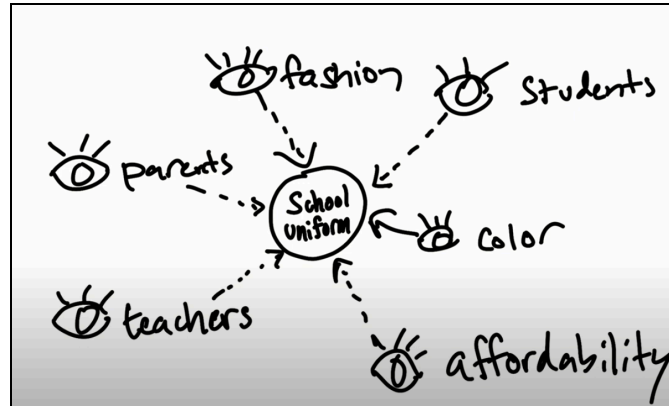


Figure D2: Screenshot from P-Circle Video

Zoom In/Out

When we think, we create meaning by structuring information from the world around us. Visualizing these structures helps us better evaluate and improve our thinking.

One way to structure our thinking is to identify parts and wholes. We can zoom in to any object, idea, or issue, and identify the various parts that make up that specific whole.

Consider a rose. Zooming in, we recognize a rose is made of distinct parts, like the stem, roots, or petals. And we could keep zooming in to find the parts of those parts.

But we can also think of something as a part of a larger whole. Consider a rose again. Zoom out, and that rose could be one part of a whole garden. If we zoom out in a different direction, the rose could be a part of symbols of love.

When we recognize that one thing can be both broken into parts and thought of as a part of a larger whole, we can better understand any object, idea, or issue.

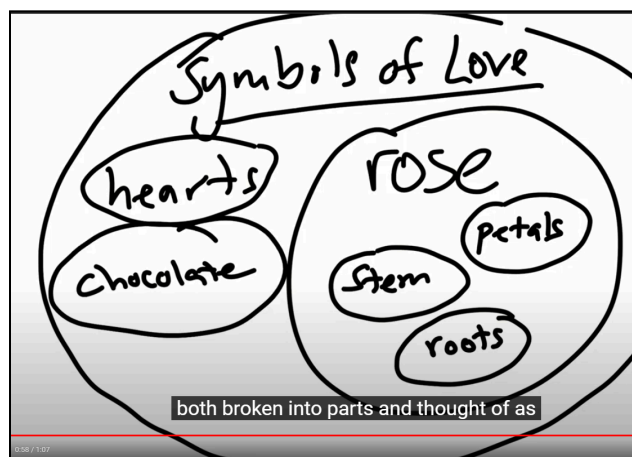


Figure D3: Screenshot from Zoom In/Out Video

RDS Barbell

When we think, we create meaning by structuring information from the world around us. Visualizing these structures helps us better evaluate and improve our thinking.

One way to structure our thinking is to see a relationship, then name it, and then zoom into it to see what it's made up of. Any one thing, whether an object, idea, or issue, can be uniquely related to another.

Consider two people. What might the relationship between two individuals be?

We have many words to describe this. Marriage, friends, or even enemies. For example, if the relationship is marriage, when we zoom in, we might see several parts: shared finances, children, and love.

Importantly, relationships can be physical or abstract. The binding of a book is a physical relationship between pages. Communication might be the relationship between a successful boss and their employees.

To better understand any object, idea, or issue, we can see relationships, name them, and zoom into their parts.

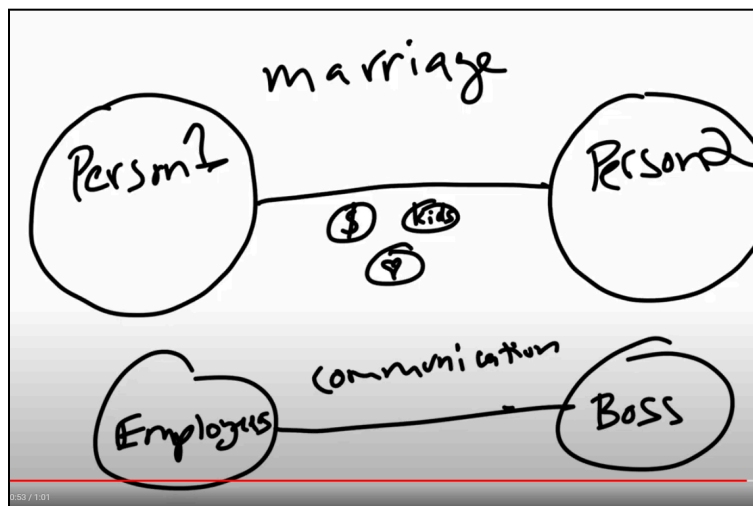


Figure D4: Screenshot from RDS Video

Part Party

When we think, we create meaning by structuring information from the world around us. Visualizing these structures helps us better evaluate and improve our thinking.

One way to structure our thinking is to identify the parts of something. We can then find the relationships between those parts.

Consider a successful business. The company is likely made up of unique departments like marketing, sales, and operations. These are the parts that make up the whole, but each department cannot succeed on its own. They relate to one another to properly function.

The sales team needs to know how the marketing department is advertising products, and the marketing department should know how sales are going to inform the ads. The operations folks, meanwhile, need to ensure each department has the proper resources.

By breaking down any object, idea, or issue into its parts and then identifying the relationships between them, we can better understand how something functions.

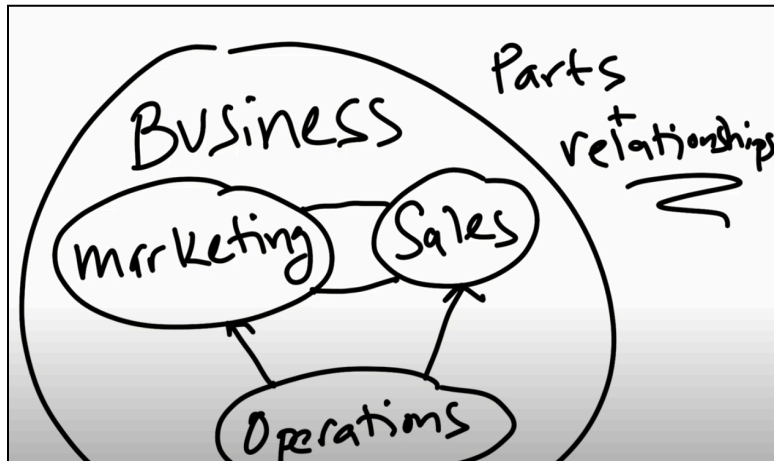


Figure D4: Screenshot from Part Party Video

Dio List

When we think, we create meaning by structuring information from the world around us. Visualizing these structures helps us better evaluate and improve our thinking.

One way to structure our thinking is to clarify distinctions. We do this by making a list of what something is and what it is not. This can be done with any object, idea, or issue.

For example, you could make two lists about an ideal sandwich. What is and is not a sandwich? For the “is” list, you might include “has bread,” “filling of meats or vegetables,” and “can be held in your hands.” Meanwhile, for the “is not” list, you might put “flat like pizza,” “empty like toast,” and “food that needs a plate.”

Listing what something is and is not helps distinguish any concept. Whether an everyday sandwich or something more significant, like a business's customer, a successful marriage, or the definition of justice. With this structure, you can be clearer about the distinctions you make to build stronger, shared understanding.

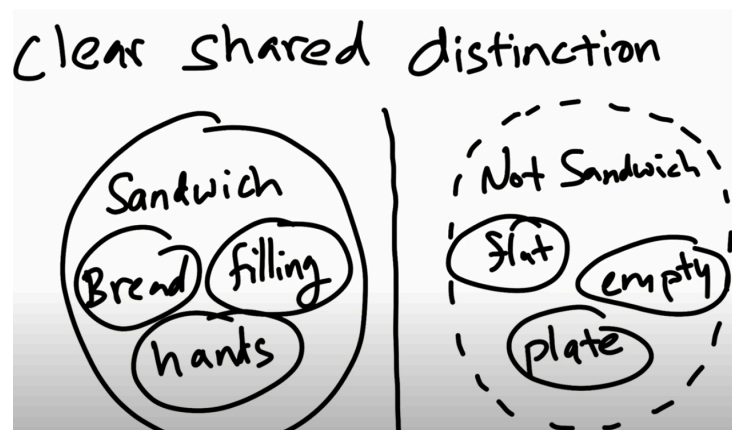


Figure D5: Screenshot from Dio List Video

Appendix E: Additional Quantitative Analysis

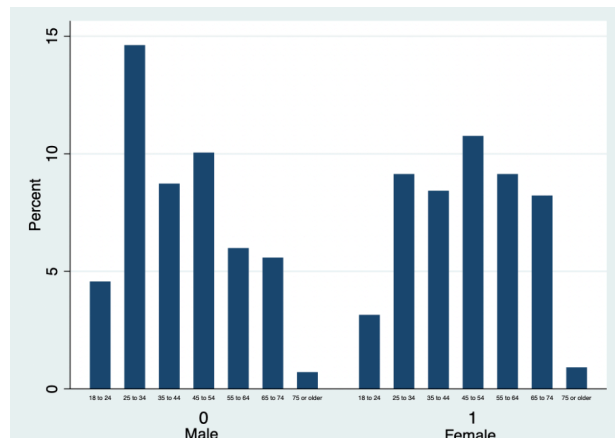


Figure E1: Descriptive Statistics of Age by Gender

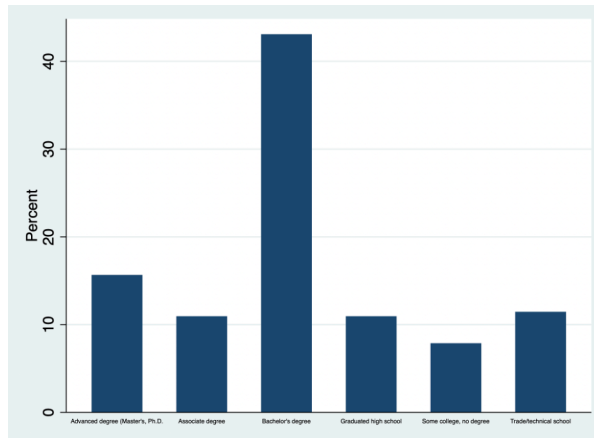


Figure E2: Descriptive Statistics of Level of Education

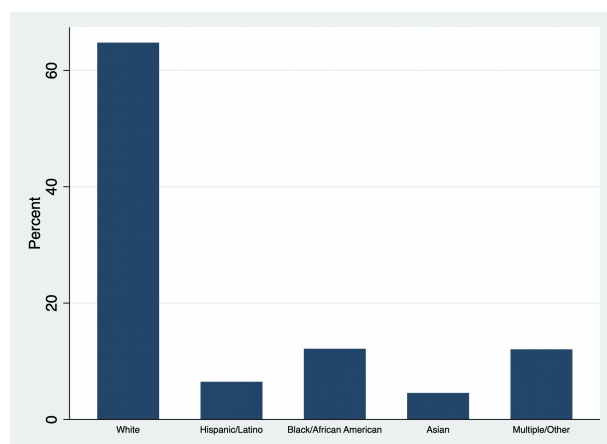


Figure E4: Descriptive Statistics of Ethnicity/Race

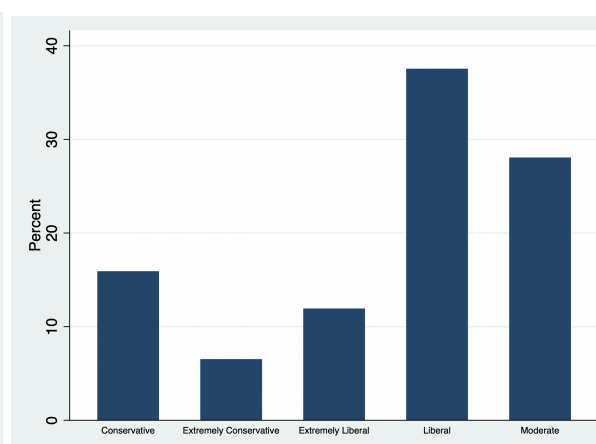


Figure E4: Descriptive statistics of Political Stance

VARIABLES	(1) Score Move
Score Move	
Post	3.470*** (0.793)
Level of Education	
Associate degree	0.702 (0.222)
Bachelor's Degree	0.615** (0.143)
Graduated High School	0.159*** (0.0791)
Some College	0.377** (0.158)
Trade /Technical School	0.217*** (0.0942)
Interaction Post and Level of Education	

Associate degree	0.829 (0.313)
Bachelor's Degree	1.094 (0.299)
Graduated High School	1.793 (0.976)
Some College	1.059 (0.503)
Trade /Technical School	2.594** (1.204)
Constant	0.308*** (0.0587)
Observations	1,954

Robust seeform in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table E1: Regression with Interaction between Post and Level of Education