A TDM STUDIO CASE STUDY

Understanding K-12 Education as a Complex Adaptive System

Leveraging Complexity Science to Enhance Educational Policy and Decision-Making

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This case study, authored by Jennifer Joyalle, Ph.D., presents the research process and key insights from her dissertation, "American Institution of Public K-12 Education: An Institutional Field Under a Complexity Paradigm."

Introduction

The inspiration for my research arose from the recognition that institutional fields, like K-12 education, operate as complex adaptive systems. This complexity became particularly apparent during the transformative period of the No Child Left Behind (NCLB) reform. Traditional social science methods often fall short in capturing the dynamic and multifaceted nature of changes within these fields. My research seeks to explore how concepts from complexity science can deepen our understanding of social systems and provide more effective tools for analyzing such complex dynamics.

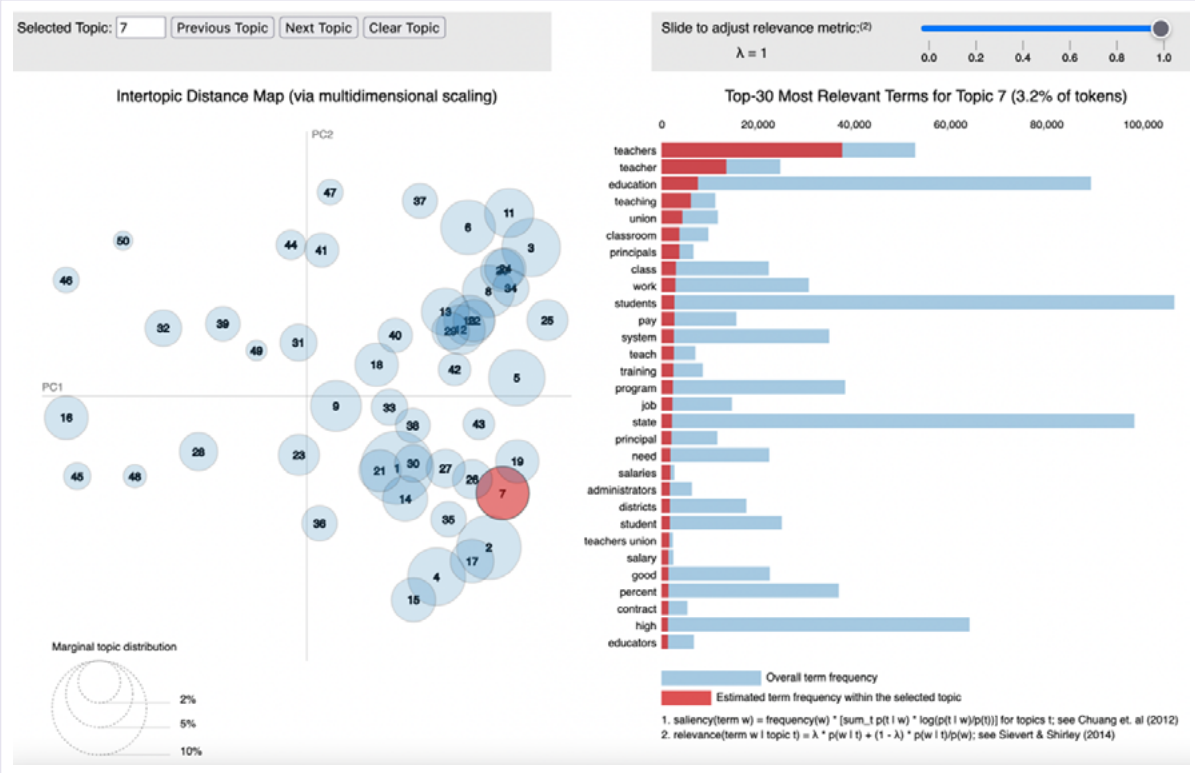
Help policymakers and leaders understand complex educational systems to inform effective decision-making.

To achieve this, I bridged social science concepts, such as institutional fields, with principles of complexity science. By integrating ideas like signals and boundaries, and utilizing advanced machine learning techniques, my study captures the interconnected, dynamic behavior of the K-12 education field. The proof of concept developed through this research demonstrates how the institutional field of K-12 education can be visualized and understood as a complex adaptive system. This approach not only offers valuable insights into the dynamics of educational reform but also meets the practical need for tools that help policymakers and leaders better understand and navigate the complexities of educational systems, leading to more informed and effective decision-making.

The Project

In this research, I established a proof of concept for defining, measuring, modeling, and visualizing institutional fields to provide valuable insights for policymakers and decision-makers. By focusing on the institutional field level of social organization, I developed a scalable methodology for studying social organizations as fields. Traditional social science methods often struggle to model organizations, institutions, and institutional fields due to their complexity as adaptive systems. However, my research overcomes these challenges by using innovative natural language processing (NLP) techniques, enabling the analysis of large textual datasets to capture detailed patterns of field-level discourse over time.

I leveraged advanced machine learning techniques such as topic modeling, sentiment analysis, and LDAvis to uncover intricate patterns within the institutional landscape. Topic modeling, in particular, helped map and visualize the dynamic landscape of competing values within the corpus. By examining the preserved metadata, including topics, words, and articles, I delved into the values embedded in the narratives. Sentiment analysis further revealed whether these values were perceived positively or negatively, offering a comprehensive understanding of the field's dynamics and how different values vie for legitimacy.



LDAvis Visualization: This screenshot shows 50 topics as circles, with size indicating prevalence and location showing relevance to other topics. The right side lists words related to Topic 7. This visualization helped reveal connections and tensions among competing values in the field of education.

Process

In my research, I set out to capture the broader narrative and public discourse surrounding education during a significant reform period. To achieve this, I utilized widely distributed newspaper publications. The five newspapers included in my study, all accessed through the ProQuest database, are *The New York Times, The Wall Street Journal, The Washington Post, Los Angeles Times*, and *Chicago Tribune*. I retrieved newspaper articles using search terms such as "education reform," "public education," "public schools," and "K-12." I also applied additional filters, including the inclusion of editorials and the exclusion of obituaries. This process resulted in a final corpus comprising 37,186 articles from these five newspaper publications. Metadata was attached to all words, topics, and dates, allowing individual articles to be located at any point in the analysis process. The methods I used within the ProQuest TDM Studio platform enabled me to fully incorporate the corpus into my study, models, and visualizations.

Identifying the corpus was a crucial first step, as it represents the data used to define the sector of the field. Next, I focused on identifying signals using topic models, topics, and themes. Topic models capture the main ideas that recur as patterns in the corpus—these are the signals that the field is either accepting or contesting, and they can be visualized as hills or valleys depending on their value disposition.

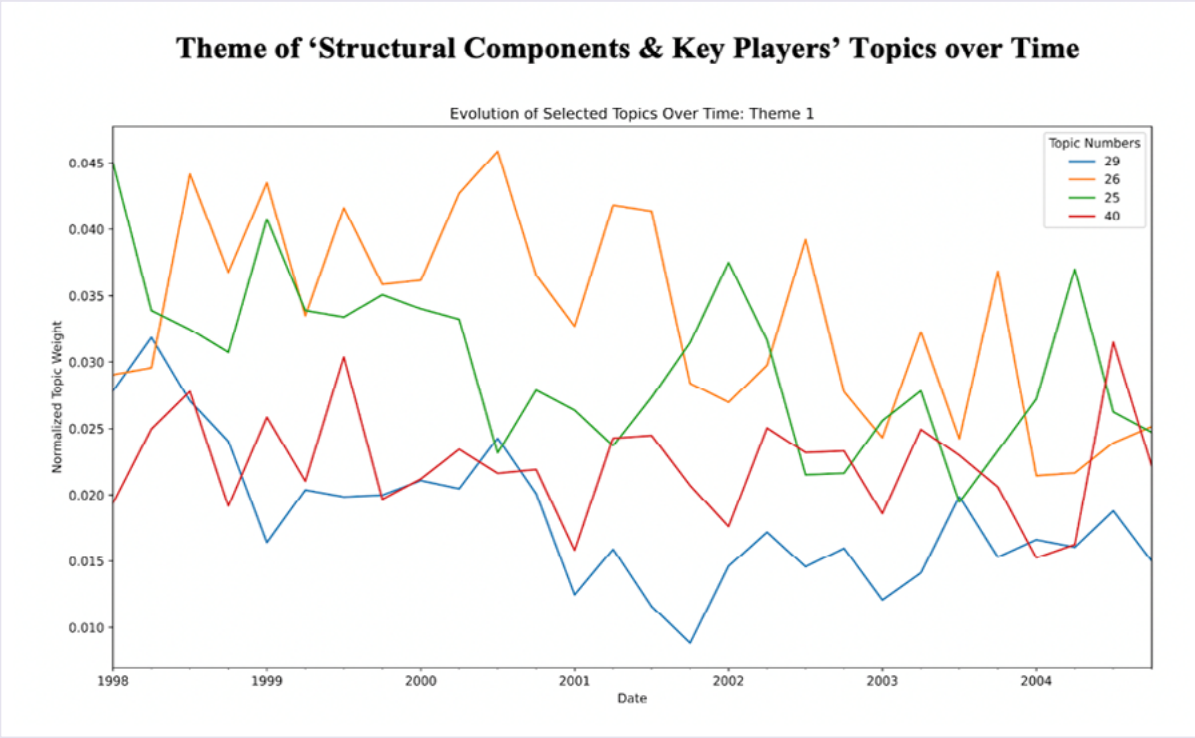
To understand the details of individual texts, I employed close reading, a technique for thoroughly analyzing specific articles, and hand coding using Narrative Values-Based Coding (NVBC) (Joyalle, 2023) to classify and interpret the data. I then examined selected value statements using the lexicon-based sentiment analysis tool VADER (Valence Aware Dictionary and Sentiment Reasoner) (Hutto and Gilbert, 2014) to determine whether the sentiments were positive, negative, or neutral, thereby showing their directionality on the landscape.

The output of the Latent Dirichlet Allocation (LDA) (Blei, D. M., Ng, A. Y., & Jordan, M. I., 2003) topic model was visualized using LDAvis, producing a two-dimensional landscape of the topics within the field. By uncovering the value statements within these topic regions and then determining their directionality, I was able to provide both depth and directionality to the landscape's topography. Observing the change in topics and sentiment over this period of discourse revealed the dynamic nature of the institutional field during this reform period.

Results

In my research, I developed a proof of concept demonstrating that it is possible to identify and model an institutional field and how it changes over time by using a corpus representing a part of that field. By applying topic modeling, sentiment analysis, and close reading of the text, I was able to identify and locate the values driving field-level behavior. The results are multifaceted, revealing the topics discussed, the prominence of these topics over time, the portrayal of topic elements, and ultimately, a visualization of the institutional field.

Through exploratory data analysis of the corpus, I determined the number of topics to include in the model and gained initial insights into the features of the corpus. I generated a topic model with 50 topics, which I further organized into themes. These themes provided a framework for digging deeper into the narratives of the articles. For example, I retrieved and coded the top 25 most heavily weighted articles under the theme "Structural Components and Key Players" using the NVBC schema, building a list of value statements found within the topics and themes.



This graph illustrates changes in the weight of five key topics within "Structural Components & Key Players" over time, including Union/Political Leaders (blue), Teachers/Principals/Students (orange), School Board/Superintendent/School System (green), and Charter/Program (red). These shifts in topic weight reflect the evolving discourse around fundamental elements and influential figures in education.

I analyzed multiple values using sentiment analysis to understand their roles within the corpus. For instance, the value of "standardization" was highly emphasized during the education reform period. By tracking its sentiment over time, I identified periods where its popularity grew or declined sharply. Shifts in sentiment from positive to negative (or vice versa) provided rich opportunities for me to return to the narrative and uncover factors influencing these competing value positions. Following "standardization" through this analysis demonstrated how the field evolved, revealing periods of deepened commitments to "standardization," times when competing values were displaced, and clarifying what the value of "standardization" aimed to exclude from the field.

In sum, my research presents a comprehensive view of the institutional field's dynamics. By showing the topics discussed, their prominence over time, the portrayal of their elements, and the visualization of these aspects, I provide a detailed description of the institutional field. Each point of data can be traced back to the narrative within the corpus, allowing the field's behavior as a complex adaptive system over time to be retold as a story of this system's evolution.

Benefits of TDM Studio

Recommended by Librarian

As a social scientist, I was familiar with traditional qualitative and quantitative methods, but working with a corpus as large as the one required for my research—comprising over 37,000 articles—was new to me. When I sought assistance from the PSU librarian, she recommended the TDM Studio ProQuest workbench.

Comprehensive Support

I chose ProQuest TDM Studio for its comprehensive "one-stop shop" capabilities, which alleviated many uncertainties related to high computer processing and storage space needs. This platform made it easier to start my project by providing straightforward and efficient methods for gathering newspaper articles. The integration of database search results ensured that the .xml structure of the articles worked seamlessly with the pre-packaged topic model scripts in the ProQuest TDM Studio Jupyter notebook. This comprehensive support removed barriers often encountered by beginning coders, streamlining the entire research process—from corpus creation to exporting model results and visualizing outputs.

Accessible User Experience

TDM Studio offers an accessible user experience, including features like easy access to corpus metadata, which allowed me to look up original articles with ease using ProQuest's unique article ID number. Inside the coding environment, the prepared scripts could be used immediately, requiring only basic coding skills, such as changing file names or pointing the script to the corpus folder. This user-friendly approach made it possible for me to efficiently manage the data and focus on my research objectives.

Support for All Levels of Researchers

One major benefit of TDM Studio for beginners is the Visualization Dashboard, which allows users to process data into topic models, sentiment analysis, or GIS maps with point-and-click features. This immediate visualization helped me become familiar with the modeling environment before transitioning to the more advanced Workbench integration with Jupyter Notebook and R. The Visualization Dashboard and the library of prepared scripts set a low barrier to entry, enabling researchers new to coding to explore advanced modeling techniques. Meanwhile, the workbench offers a high ceiling for what is possible within TDM Studio, providing advanced capabilities for experienced users. Practicing with TDM Studio's prepared scripts enabled me to build my coding skills and customize the models to meet my specific research needs.

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