

Understanding Teacher Attrition in Nebraska Public Schools Through Markov Chain Analysis and Graph Theory

Application for 2024-2025 Graduate Research and Creative Activity (GRACA) Grant

University of Nebraska- Omaha (UNO)

M.S Student: Md Tahidul Islam

Faculty Mentor: Dr. Mahbubul Majumder

Data Science / Concentration: Mathematics

Project Description:

a. Description of Project:

Teacher attrition is a critical issue affecting public schools in Nebraska, leading to disruptions in learning, increased recruitment and training costs, and diminished educational outcomes. Both rural and urban districts are experiencing challenges in retaining qualified educators, particularly in specialized areas like STEM and special education. Addressing this issue is essential for ensuring a stable and effective educational environment for students across the state.

The goal of this project is to use advanced data science techniques, specifically Markov Chain analysis and Graph Theory, to explore the factors driving teacher attrition in Nebraska public schools. Markov Chain analysis will model the career transitions teachers undergo, such as staying in their current role, moving to a different district, or leaving the profession entirely. By understanding these transitions, the project will identify key stages in a teacher's career where attrition is most likely to occur.

Graph Theory will complement this analysis by visualizing the complex relationships between various factors that influence teacher attrition, such as gender, ethnicity, years of experience, and geographic location. This approach will help uncover patterns and dependencies that may not be evident through traditional statistical methods, providing a more holistic understanding of the issue.

The dataset used for this project includes teacher workforce data from the Nebraska Department of Education, covering the years 1983 to 2021. This rich dataset will allow for a detailed and comprehensive analysis of teacher demographics, employment history, and school characteristics. The combination of Markov Chain and Graph Theory techniques will provide insights that can inform policy decisions aimed at reducing teacher turnover and improving retention rates.

Ultimately, the findings from this research will equip policymakers and school administrators with evidence-based strategies to improve teacher retention. Potential interventions could include

targeted mentorship programs for early-career teachers, enhanced professional development opportunities, and support systems designed to reduce burnout and increase job satisfaction. This project will not only contribute to the academic literature on teacher attrition but also have a direct impact on shaping education policy in Nebraska.

b. Activities, Process, or Methodology:

This project will employ a multi-phase process:

1. Data Collection and Preparation: The project will use teacher workforce data from the Nebraska Department of Education, spanning from 1983 to 2021. Data cleaning and processing will be performed to ensure accuracy, consistency, and completeness of the dataset.

2. Markov Chain Analysis: A probabilistic model will be developed to represent teacher transitions between career states. This analysis will allow for the identification of high-risk stages in teacher careers where attrition is most likely.

3. Graph Theory Application: A network analysis will be performed using Graph Theory to visualize and analyze the relationships between factors such as demographic information (gender, ethnicity), years of experience, and geographic location. These analyses will reveal patterns that may not be evident through traditional statistical methods.

4. Reporting and Results: The final results will be presented in a report, outlining key findings and providing recommendations for policies aimed at reducing teacher attrition in Nebraska public schools.

c. Project Timeline:

Period	Activity
February 2025	Literature review and data preparation.
March 2025	Markov Chain analysis to model teacher transitions.
April 2025	Graph Theory analysis to visualize relationships between factors and writing a final report.
May 2025	Submitting Final report.

d. Student/Faculty Mentor Roles:

- **Student (Md Tahidul Islam):** As the primary researcher, I will be responsible for reviewing literature, preparing and cleaning the dataset, conducting the Markov Chain and Graph Theory analyses, interpreting results, and writing the final report. I will also submit the report.

- **Faculty Member: Dr. Mahbubul Majumder**, Associate Professor, MS Data Science Graduate Program Chair, Department of Mathematical and Statistical Sciences at UNO, and my M.S. advisor, will monitor and moderate the data analysis and modeling, and provide feedback on deliverables.

e. Previous Internal Funding:

I have not received any previous internal funding for this research.

Budget and Budget Justification:

The total requested amount is **\$5,000**. This will cover the student researcher's time and effort from February, 2025 to April, 2025, including data analysis, model development, and report writing.

References and/or Citations:

[1] Borman, G. D., & Dowling, N. M. (2008). Teacher Attrition and Retention: A Meta-Analytic and Narrative Review of the Research. *Review of Educational Research*, 78(3), 367-409. <https://doi.org/10.3102/0034654308321455>

[2] Guarino, C. M., Santibañez, L., & Daley, G. A. (2006). Teacher Recruitment and Retention: A Review of the Recent Empirical Literature. *Review of Educational Research*, 76(2), 173-208. <https://doi.org/10.3102/00346543076002173>

[3] Ingersoll, R. M., Merrill, E., Stuckey, D., & Collins, G. (2018). The changing face of the teaching force: A report from the Consortium for Policy Research in Education. CPRE Research Reports. https://repository.upenn.edu/cpre_researchreports/108/

[4] Achinstein, B., Ogawa, R. T., Sexton, D., & Freitas, C. (2010). Retaining Teachers of Color: A Pressing Problem and a Potential Strategy for "Hard-to-Staff" Schools. *Review of Educational Research*, 80(1), 71-107. <https://doi.org/10.3102/0034654309355994>

[5] Sinha, D. (2022). Identifying factors of teacher attrition in Nebraska: A survival model approach (Master's thesis, University of Nebraska at Omaha).

[6] Ronfeldt, M., Loeb, S., & Wyckoff, J. (2013). How Teacher Turnover Harms Student Achievement. *American Educational Research Journal*, 50(1), 4-36. <https://doi.org/10.3102/0002831212463813>

The GRACA program
Office of Research and Creative Activity
University of Nebraska Omaha

Dear GRACA Review Board

I am writing to express my strong support for Tahidul Islam and his proposed research project, "Understanding Teacher Attrition in Nebraska Public Schools Through Markov Chain Analysis and Graph Theory." The project focuses on understanding teacher attrition in Nebraska using data from the Nebraska Department of Education. As Tahidul's advisor, I have had the pleasure of observing his academic progress and passion for using data-driven solutions to address complex educational challenges.

The proposed project aims to analyze key educational data to assist the Nebraska Department of Education in making informed decisions to enhance student performance by understanding teacher attrition and improving educational policies. Through the use of data analytics, Tahidul will explore patterns in teacher attrition in Nebraska, along with demographic and other factors related to attrition, and will apply methods such as Markov Chain Analysis and Graph Theory to explain these patterns. The insights gained from this project will be invaluable for shaping policy decisions that benefit both students and teachers across the state. The results will be shared through the Nebraska Education Policy Research Lab (NEPRL) at the University of Nebraska Omaha (UNO).

I will be meeting with Tahidul on a weekly basis to provide guidance and mentorship throughout the course of the project. Our meetings will ensure that the research stays on track and that the project adheres to high academic and professional standards. I am confident that, as a data science graduate student at UNO, Tahidul has the skills, determination, and intellectual curiosity to carry out this work successfully and to make a meaningful contribution to the field of education.

In conclusion, I wholeheartedly support Tahidul's research proposal and look forward to seeing the positive impact his work will have on the Nebraska Department of Education. Should you need any additional information, please feel free to contact me.

Sincerely yours,



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