

Exploring the Transformative Intersection of Artificial Intelligence and Educational Research: K-12 Principals Supporting English Learners

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Abstract: The integration of artificial intelligence (AI) into educational research marks a significant paradigm shift where AI intersects with educational research from diverse perspectives, emphasizing its transformative potential. By leveraging AI technologies, researchers can transcend traditional limitations, thereby enhancing their capabilities to pose more incisive questions, analyze vast datasets, and refine research methodologies, ultimately leading to more impactful outcomes. Within the context of a research endeavor focused on K-12 principals supporting classroom teachers serving English Learners in the United States, we explore how AI algorithms can refine research questions and augment research methodologies, leading to deeper insights and more informed decisions in educational studies. Innovative techniques for optimizing survey questions and methodologies are discussed, showcasing AI's analytical prowess in unlocking new avenues of understanding and leading to deeper insights and more informed decisions in educational research studies. Through advanced data processing techniques, AI unveils patterns, correlations, and insights that may elude traditional analysis methods. This analytical prowess not only facilitates deeper understanding but also empowers researchers to make more informed decisions. Moreover, AI augments research methodologies by offering innovative techniques for optimizing research questions and methodologies. By harnessing AI's analytical capabilities, researchers unlock new avenues of understanding, leading to more comprehensive and nuanced studies. The realm of AI-driven skill enhancement for researchers is addressed by illustrating the process in the context of a study that seeks to gain a deeper understanding of the strategies principals employ to develop teachers working with English learners. This collaborative approach enriches individual research endeavors and contributes to the collective advancement of research methodologies within the educational landscape. We highlight the transformative potential of AI in revolutionizing educational research practices and enhancing outcomes for English learners in the K-12 education system. By leveraging AI, researchers can improve their interviewing techniques, refine performance, and foster a culture of continuous improvement. AI-powered tools provide real-time feedback and facilitate iterative refinement of practices. This collaborative approach can enrich individual research endeavors and contribute to the collective advancement of research methodologies within the educational landscape.

Keywords: Artificial intelligence (AI), Educational evaluation, Transformative potential, K-12 principals, English/multilingual learners

1. Introduction

The use of artificial intelligence (AI) in research surpasses traditional limitations in the field. AI allows researchers to pose more incisive questions, efficiently and effectively synthesize empirical (e.g., qualitative, quantitative, mixed methods) data, and refine methods for actionable results (Alasadi & Baiz, 2023; Holmes & Tuomi, 2022; Zhai et al., 2021). AI capabilities and their use in research is new and constantly changing, and with that comes the responsibility of researchers to document the use of AI in the research process including intended and unintended consequences (Bozkurt et al., 2021). In this paper, we explain how we integrate AI into a qualitative study that investigated what skills and competencies principals need to support teachers serving English Learners (ELs) and, if skills to support teachers serving ELs exist, how are these skills are obtained and developed across time. We focus on when AI was used, how we used it, where we increased our efficiency as researchers, and when we thought it necessary to cross-validate AI generated work products with a human review. This research is currently in process with final data collection and analysis expected to be complete in October 2024.

2. A Case Study: K-12 Principals and English Learners

School principals, second only to teachers, serve as critical levers to the academic success of students (Louis et al., 2010). Given this influence, and the complex operational responsibilities of their daily work, principals need to be intentional on how they support the instructional practices that lead to high levels of student learning. This not only includes more attention demanding subjects of math and reading, but the often overlooked and

underserved students who also deserve their principal's focus, namely ELs. To that end, this qualitative study aimed to understand how principals support teachers of ELs. The study was guided by the following overarching research question: What skills and competencies do principals have to support teachers of ELs? A sub-question explored how these skills were acquired and developed. Using convenience sampling, we recruited 12 principals from a large metropolitan area in the United States, with at least three years of experience in schools serving EL students. Participants included elementary, middle, and high school principals from urban, suburban, and charter districts. Some participants also had preschool and district-level leadership experience. Through semi-structured interviews via Zoom, participants were asked a series of 15 open-ended questions to allow for detailed responses. Interviews lasted 45-60 minutes and were recorded and transcribed.

Data were analyzed through thematic analysis by repeatedly reading the transcripts, manually coding data, and identifying themes (Glesne, 2016). We are now applying AI technology to summarize interviews and confirm key ideas now that the traditional process of coding and theme identification is final (Dhopavka et al., 2023). Although a rigorous traditional process for analyzing qualitative research data was applied first, we felt it was important to recognize the potential positive influence of using AI algorithms to complement the human approach. Upon completion of both the traditional and AI analytic process, we will compile a definitive list of themes, supported by direct quotes, and use pseudonyms to protect participants' identities. Preliminary findings reveal three professional practices for school principals: 1) embed professional learning on best instructional practice for ELs, 2) cultivate supportive relationships with teachers of ELs, and 3) prioritize inclusionary practices for EL students. Next, we highlight how to utilize AI tools to complement and enhance our human approach.

3. Advancing Research with AI Innovations

The recent surge in investments into physical hardware chips for AI is due to the processor-intensive nature of AI tasks on current graphic processing units (GPUs) and computing architectures (Khan & Mann, 2020). Traditional hardware is inefficient for AI's complex algorithms and diverse models that need to process and analyze vast amounts of data for pattern detection and prediction. As researchers, choosing the appropriate AI model for our data is a critical decision. This same question is being posed by governments and industries seeking to unlock growth and opportunities by identifying patterns in their data. Data scientists extensively employ mathematics, statistics, and computer science, to develop advanced analytical techniques to enhance data trustworthiness (Provost & Fawcett, 2013). Before selecting an AI model for data analysis, it is essential to implement a well-defined data quality management (DQM) framework to ensure data integration, validity, and consistency. A proper DQM is crucial for ensuring the accuracy and reliability of AI models in identifying patterns and making predictions, whereas a poorly implemented DQM can compromise the validity and accuracy of the predicted outcomes (Haukkala, 2022).

Decision trees, linear regression, and logistic regression are common machine learning models that can be applied to data for various analyses (Dumitrescu et al., 2022). Before selecting the appropriate AI technology/ies to investigate outcomes or patterns, a careful evaluation of these options is necessary. Once the most suitable AI technology/ies is chosen, a subset of data collected by researchers can be used to train it. The newly created AI model requires rigorous scrutiny regarding its accuracy and performance, necessitating evaluation by subject matter experts. In certain research scenarios, data structuring is either impossible or difficult to achieve, such as with transcribed interviews, open-ended survey responses, and documents containing policies and processes. For these types of unstructured data, the best AI models to locate intent is natural language processing (NLP) combined with machine learning (Goyal et al., 2018). NLP does not support predetermined models for complex reasoning, making prompt engineering strategies such as chain of thought (CoT) prompting essential for achieving repeatable desired outcomes (Besta et al., 2024). Repeating clearly defined and specific steps to process NLP requests against unstructured data can be daunting, which is where leveraging application process integration (API) with predefined runbooks can enhance consistency.

4. Innovative Techniques and Analytical Prowess of AI

Educational researchers, particularly using qualitative methodological approaches, can invest considerable time reviewing, summarizing, and interpreting research findings. AI is a tool that allows researchers to integrate multiple data sources simultaneously increasing efficiency and accuracy, compared to the human-exclusive approach (Kasperiniene & Mazeikiene, 2024). In our study, for example, the team collected quantitative data from publicly available state data describing the participating schools (e.g., percentage of students who met academic achievement standards, percentage of students who are English Learners,), school and district website information, and contextual data via the interviews. Three themes emerged through an iterative human and AI

investigative process described previously. Using AI, our research team is currently investigating more complex questions about these themes and extant data. For example, we are currently exploring how one prominent theme from the interviews, embedded professional learning on best instructional practices for ELs, differs in relation to the size and location of the school and the leadership type of the principal. Further, the team is analyzing how two prominent themes, embedded professional learning and supportive relationship with teachers of ELs co-exist in the schools. The algorithm is aiding the researchers in reducing the time allocated to making these comparisons.

The integration of AI into the research process is also allowing the team to investigate more advanced methodological questions. In traditional qualitative analysis, much of the time allocated to the work is identifying similar and contrasting themes across interviewees. Time might also be allocated to how and under which circumstances the themes are present. The intensity at which the team synthesizes qualitative data to answer the research questions leaves little time left to answer secondary or methodological questions. The implementation of AI into this research study, however, freed up time for the team to answer both research and methodological questions (Srinivasa et al., 2022). Preliminarily, the team has found that one veteran interviewer has been the most effective at getting the interviewees to “discuss specific aspects of their experiences and insights in educational administration and support for English Learners (ELs)” (OpenAI, 2024) because of their ability to ask structured questions across interviews. Using AI, we imported the summarized, cleaned transcripts which included the interviewer and interviewee names. AI was prompted to compare the interviews and summarize in a table (see Figure 1).

| Aspect | Interview 1 | Interview 2 | Interview 3 |
|-----------------------------------|--|--|---|
| Role | Principal of Davis Middle School, Dublin | Not specified in the provided content | Director of Career Tech Education, Columbus City Schools |
| Focus on EL Support | Direct work with EL teachers, advocacy for more staffing | Discussion on broader strategies for EL support | Implementing shelter sites and instructional assistance |
| Training in EL Support | Lack of specific training during academic studies | Not specified in the provided content | Lack of specific training in academic studies |
| Experience with ELs | Experience in schools with varied EL support structures | Focus on parent engagement, cultural integration | Early experiences with growing Somali population at Indianola Middle School |
| Challenges Mentioned | Space constraints, need for bilingual assistants | Not specified in the provided content | Special education strategies, need for bilingual staff |
| Ideal EL Support Structure | Bilingual assistants, grade-level specialists | Not specified in the provided content | Not specified in the provided content |
| Length of Interview | Approximately 27 minutes | Approximately 35 minutes | Not specified in the provided content |

Figure 1: Comparing three AI generated interview prompts

This allows the researchers to review the quality of the interviews and set the stage to conduct a secondary analysis using AI in which the system identify the interview with the “best” answers and the criteria that the system used to identify “best.” Currently, the research team is determining which interview questions solicited more insightful information and to what extent those insights are shaped by the skills and experiences of the interviewee/interviewer.

Whether utilizing AI to tackle complex research questions or to address methodological inquiries, our team integrated traditional research approaches with nuanced AI techniques. Specifically, we document the prompts given to AI and the system's responses in run books, particularly using "change of thought" prompting. This documentation helps the team understand how early investigative questions influence both immediate and long-term results generated by language models. Additionally, it strengthens our methodological approach and provides a basis for colleagues to review and critique, considered an essential process for all research (Owan et al., 2023).

5. Advocating for a Hybrid Research Approach

While AI offers substantial advantages, it also has shortcomings that necessitate the continued use of traditional research methods (Khlaif et al., 2023). Since AI's feedback is based on patterns and data recognition, it can miss the subtleties of human interaction and the qualitative depth that traditional methods capture. AI may not fully grasp the context-specific nuances or the personal and emotional dimensions of the principals' experiences with ELs. For instance, AI might not always interpret the cultural or situational context accurately, leading to less relevant or inappropriate follow-up questions. Furthermore, the reliance on AI tools might lead to an overemphasis on quantifiable data at the expense of rich, qualitative insights that come from human intuition and deep listening.

Traditional methods, such as face-to-face interviews and manual analysis of transcripts, are crucial for capturing the complexity and depth of principals' experiences and perspectives. These methods allow researchers to build rapport with participants, understand non-verbal cues, and apply their contextual knowledge to interpret responses more holistically. For example, in exploring how principals support EL instruction, traditional approaches enable researchers to consider the broader educational environment and cultural factors influencing these practices. These methods are essential for ensuring that the study's findings are grounded in a thorough understanding of the principals' contexts and experiences, beyond what AI alone can provide. Perhaps the most effective research approach combines the strengths of AI with traditional methods. AI enhances the efficiency and adaptability of the research process by providing real-time insights and enabling iterative refinement, while traditional methods ensure a deep understanding of the context (Sayar et al., 2023). This hybrid approach allows researchers to harness the technological advantages of AI while maintaining the human-focus essential for exploring complex educational phenomena like the support of ELs by K-12 principals and teachers.

In our study, AI enhances the triangulation of data, contributing to a more robust and comprehensive understanding of how principals support teachers of ELs. For example, AI can analyze interview transcripts from principals to detect consistent themes or discrepancies in how EL support is implemented and perceived. This capability enhances the depth of analysis by providing a multidimensional view of the principals' roles and the effectiveness of their strategies in supporting ELs.

AI tools, however, are limited in their impact in triangulation. While AI excels at identifying patterns and processing large datasets, it may struggle with the nuanced interpretation of qualitative data, such as understanding the context-specific meaning of principals' experiences or capturing the subtleties of human interactions. This can lead to a reliance on surface-level patterns rather than deeper contextual insights. Further, AI's analytical outputs require careful interpretation by researchers to ensure they are meaningful and contextually relevant (Vincent-Lancrin & Van der Vlies, 2020). For example, AI might flag a correlation between a specific instructional practice and EL student performance, but it is the researchers' role to investigate and validate this finding within the broader educational context. Without human oversight, there is a risk of misinterpretation or over-reliance on AI-generated results and that can limit the depth and accuracy of triangulation.

6. The Potential for AI-Driven Skill Enhancement for Researchers

With an understanding of the benefits and potential limitations of AI, we now offer three examples to improve a researcher's interviewing technique using AI as a support mechanism (Yadav et al., 2023). First, AI supports the use contextual probing to dive deeper into the specific challenges and practices of K-12 principals in supporting teachers of ELs. For example, when a principal described how a teacher can deliver a new instructional plan for ELs, AI can remind the researcher to probe with questions like, "Can you describe how this instructional strategy addresses the specific needs of your EL students?" or "What feedback have you received from teachers and EL students regarding this approach?" This technique helps uncover detailed insights into the effectiveness and application of strategies, providing a deeper understanding of the principals' efforts and the

challenges they face. Second, using scenario-based questions, researchers can use AI to generate scenario-based questions and then incorporate these into their interviews to elicit and/or extend detailed responses about how principals handle specific situations involving ELs. For example, a researcher poses hypothetical or past scenario questions such as, “Imagine a situation where a significant number of EL students are struggling with a particular concept. How would you suggest to a classroom teacher that they address re-teaching this concept?” or, “Can you recall a time when you had to make a crucial decision regarding EL instruction? What steps did you take, and what was the outcome?” Scenario-based questions encourage principals to reflect on their experiences and decision-making processes, revealing their problem-solving approaches and the impact of their actions on EL instruction. Last, as previously suggested, researchers can utilize AI-powered tools to provide real-time feedback and question suggestions during interviews. They can apply AI to monitor the interview and provide timely suggestions for additional questions or areas to explore based on the principal's responses (Thompson et al., 2021). For example, if a principal refers to using data analytics to track EL progress, AI can suggest follow-up questions like, “What specific data measures do you find most useful in tracking EL student progress?” or “How has data analysis changed your approach to supporting teachers and ELs?” AI-powered feedback ensures that the researcher remains adaptive during the interview, allowing for deeper exploration of relevant topics and immediate identification of new lines of inquiry that were not pre-planned. By highlighting important but potentially overlooked areas in real-time, AI allows researchers to adjust their approach to ensure interviews yield relevant insights. This responsiveness is crucial for exploring the complex role of principals in addressing EL needs, enabling researchers to gain a richer understanding of how instructional leadership is practiced in diverse educational contexts.

By integrating AI tools, researchers can develop a more iterative approach to interviewing, constantly refining their techniques based on real-time and post-interview feedback. This fosters a culture of continuous improvement, where each interview informs and enhances the next, leading to more meaningful data collection. This approach improves the quality of findings that are more comprehensive and actionable, contributing to the development of practices for supporting ELs. In essence, AI enables researchers to be more agile and insightful in their interviewing process, ultimately enriching the study's contributions to our field.

7. Conclusion

AI has the potential to transform the educational research landscape. AI increasing efficiencies in areas that were time intense with the human only approaches (e.g., reading, reviewing transcripts, coding unstructured data) leaving more time for researchers to learn from and add to investigative process (e.g., refinement of data collection protocols, feedback loops for improved interviewing techniques, and simultaneous analysis of qualitative and quantitative data). AI can also more effectively translate research findings to best practices, where the research to practice connection has often been weak or sometimes non-existent. This new frontier, however, comes with an added responsibility for researchers. This includes the need to cross-validate AI products to ensure its accuracy and trustworthiness, document the process the researcher interacts with AI via run books, and to skill up on the various AI algorithms available including their alignment with the methodological approach used in the study.

While AI enhances the research process by providing powerful tools for integrating and analyzing diverse data, leading to a more robust understanding of how K-12 principals support ELs, its effectiveness is maximized when combined with traditional qualitative analysis methods. This ensures that the richness and contextual nuances of the data are fully captured and interpreted. This hybrid approach leverages the strengths of AI in data processing and pattern recognition while relying on human expertise for contextual understanding and nuanced interpretation, ultimately enhancing the study's validity and reliability.

We believe that AI has the potential to add additional value to the field of research by providing real-time feedback and suggestions based on the ongoing conversation, helping the researchers delve deeper into the backgrounds, experiences, and practices of K-12 principals. For example, if a principal mentions a particular challenge in supporting teachers of ELs, AI can prompt follow-up questions that explore this issue further and/or suggest related topics that the principal might have overlooked.

Additionally, AI has the potential to analyze speech patterns and the emotional tone of responses (Dwivedi et al., 2022), guiding interviewers on when to probe more deeply or shift the conversation to new areas. Post-interview, AI could quickly transcribe and summarize the conversation, identifying key themes and areas for further exploration. This enables researchers to refine their interview techniques continually, adapting their approach based on real-time insights and feedback. Overall, AI's capability to enhance both the content and

conduct of interviews allow us to gather richer, more nuanced data on the principals' efforts to support teachers of ELs, ultimately contributing to a more comprehensive understanding of how to support ELs.

As outlined in the introduction, the integration of AI in research offers new opportunities to push beyond traditional limitations, enhancing data synthesis and refining methodologies for actionable results. In our study, we employed AI to explore the skills and competencies K-12 principals need to support teachers of English Learners (ELs). Through our use of AI, we aimed to increase our efficiency, document both its intended and unintended effects, and cross-validate AI-generated insights with human analysis to ensure data reliability. However, the use of AI in research is not without challenges. As highlighted in the conclusion, although AI greatly reduces the time required for tasks like transcript coding and data analysis, its real strength is realized when it is combined with traditional qualitative methods. This hybrid approach ensures that AI's strengths—speed, data processing, and pattern recognition—are balanced with human expertise in contextual understanding and nuanced interpretation. While AI's integration into our research deepened our analysis, we also gained valuable insights for the evolving field of educational research, particularly in its application to improving support for ELs.

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