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A Critical Analysis: How Foundational Theories from the Past are used in Current AI Literacy Research

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Abstract

The study is a critical review of four renowned theorists and how their theories compare with current Artificial Intelligence (AI) research trends taking place and the models being used to implement this latest technology into college classrooms. The four researchers reviewed are: Jean Piaget, Robert Gagne', Leslie Briggs, and Gavriel Salomon all of whom have had a great impact on the evolution of the use of technology in education. The study reviews current AI literacy research and analyzes if this research relates to these past theorists and if so, how.

Keywords: *AI in higher education, AI literacy, educational technology theory*

Introduction

To understand where the field of education is headed in the future it is important to revisit its past. In the age of Artificial Intelligence, the use of new technologies has virtually exploded, and educators are scrambling to keep up by using this technology at an increasing rate. Thus, it is important to understand how to integrate this new technology into the learning process. Past research and theorists have already led the way in understanding the use of technology in education. The history of educational technology pedagogy is vast and complex and encompasses theories that have been embraced by many a discipline. Potential trends evolving in education today can be traced back to several important theorists who set the stage for this new age of technology. An age built upon the use of ever emerging tools to aid technology literacy and education. These theorists reflect a paradigm shift from analyzing media hardware to discovering the science of learning and the role of the learner in that process. Revisiting these theories will help provide a foundation for the use of present and future technologies in the college classrooms.

For this analysis several important theorists that have and are still making a major impact on the field of education will be reviewed. This study examines four renowned theorists: Jean Piaget, Robert Gagne', Leslie Briggs, and Gavriel Salomon all of whom have had a great impact on the evolution of the use of technology in education and then critically analyzes current AI literacy research in higher education to see if this research relates to these past theorists and if so, how?

Literature Review

There have been many research agenda setting books and studies (Gagne, 1977 & 1986; Gagne et al., 1974, Hounsell, 2003) examining the use of technology in education and some of the most recent research (Carstens et al., 2021; Haleem et.al., 2022; Price & Kirkwood, 2014, Raja & Nagasubramani, 2018), continues to discuss several different techniques for improving learning by using technology in education. The research and studies of how-to best use technology in college classrooms continues to evolve with every new technology developed. What appears to be consistent in this research is that past instructional models are still being used to this day even though these models (Gagne et al., 1974; Gagne', Briggs et al., 1988) may not be recognizable in the latest iteration of how to integrate technology in higher education. Educators and researchers appear to be reinventing the wheel every time a new technology enters the classroom and yet, these new models and theories appear very familiar. Most current research uses past theories to support or be the foundation of new research that is the standard of quality academic studies. However, this type of research usually changes, updates, or refutes the past theories and some develop new theories and models. The instructional models and theories being utilized today in AI studies and in particular AI literacy research claim to be new and/or innovative but are the same models and theories that have worked for decades such as Gagne' & Briggs instructional design theory.

Foundational Theorists Who Impacted and Continue to Impact Technology in Education

Piaget, Gagne and Briggs concepts have been so influential it is hard to imagine the field of educational technology without them. Their theories analyze learner development and systematic instruction. It is obvious that technology cannot be an effective tool if the teacher is unaware of the learner's capabilities, and therefore designs the incorrect system of instruction. There are many factors to take into consideration in instructional design. Piaget and Gagne analyzed two important factors in the learning process which were cognition and systematic instruction.

Jean Piaget found that cognition developed from contact between the learner and the environment. There are two terms from his cognitive theory that describe this relationship. Assimilation occurs when the learner copes with a situation that was originally too difficult while accommodation is the learner adjusting to a new environment and adding this new information into his/her scheme. Piaget believed scheme was, "the structure that adapts and adaptation is the cognitive striving of the learner to achieve equilibrium between himself and his environment" (Saettler, 1990, p. 74). He questioned these different processes of change by analyzing the development of cognition. Finally, there was a new perspective on the learner that included the environment of the learner and the learner's cognitive abilities.

How is this theory influential in the field of educational technology? It provides a scientific perspective on the cognitive development of learners. By understanding the mind of a learner, an instructor is given the ability to create better designs and utilize the correct tools. Piaget's theory gives researchers a basis on which to build knowledge. It allows researchers to develop systems of instructions by looking at the individual's internal scheme in connection with his/her

environment. Perhaps, this is why Gagne'& Briggs theory of instruction appears to be an extension of Piaget's theory of cognition.

It is important to note that Gagne' analyzed old and new principles of learning theories. According to their theory and model, there are two factors involved in a learning event: external factors that utilize contiguity, repetition and reinforcement as well as internal factors that use evidence-based information, intellectual skills, and strategies. These factors are principles used by an instructor to aid in the learning process. Gagne' & Briggs thought of "human learning as a set of internal cognitive processes that transform the stimulation presented to the learner into several successive phases of information processing" (p. 49). The result of this information processing is learning outcomes which consist of:

- intellectual skills (aid the student in carrying out symbol-based procedures),
- cognitive strategies (aid the learner in cognitive processing),
- information (facts are organized and stored in memory),
- motor skills (the physical activity required for purposeful actions),
- attitudes (modify an individual's choices of action) (Gagne' et al., 1974, p. 51).

This model is defined as instruction and the learning situation is enhanced when certain conditions are met. These conditions are performance acquired as a result of learning internal conditions as needed to be present for learning and finally, external conditions established to bring stimulation to the learner. It is evident that one can make a parallel between Piaget's theory and Gagne' & Briggs' theory. Both theories (Piaget, 1954 & 1957; Gagne' et al., 1974) take into effect external and internal conditions although they analyze the learner from different perspectives. Piaget is defining the learner while Gagne' and Briggs are developing a system to instruct the learner.

There are a variety of theories that have impacted the field of educational technology such as humanistic, psychological, behaviorist, etc. (Althaus, S., 1997; Bond et el., 2020; Brown, J., 1988; Carstens et al., 2021; Deden, A., 1998; Haleem et al., 2018; Hiltz, S., 1986, 1994; McComb, M., 1994; Price et al., 2014; Raja et al., 2018; Walther, J., 1996; Witmer, D., 1998). Many have been influential in shaping the field, but few have made the unique impact of Piaget's Cognitive theory and Gagne' & Briggs' theory of instruction. These theories provided new approaches in analyzing learner cognitive development, instructional development, and proper integration of technology in the classroom. It would be extremely difficult to implement many models in the field of educational technology without an understanding of the learner and his/her environment. Once this is accomplished, there is a need to develop a proven system of instruction for without proper instruction the entire process becomes useless. These theories are not only representative of the ever-changing field of education and technology but make a contribution that can be seen today. Their endurance supports the fact that Piaget's cognition theory and Gagne' & Briggs' theory of instruction are continuing to be influential. Yet, these theorists are only part of the puzzle of aiding the learning process using technology in education. Further investigation of technologies such as AI as a tool of education has revealed insightful new information with the help of theorists from the past like Gavriel Salomon. It is in better understanding the theories of the past that one can improve present research in AI and AI

literacy. For there to be successful advances in the field of education, we must break the bonds of our self-imposed imprisonment. A revitalizing escape may be to analyze past researcher's concepts on technology as a tool for expanding the studies on AI literacy.

Gavriel Salomon's theory of cognition argued that each medium has its own inherent symbol system, which therefore affects the message. These symbol systems offer added information and expand the learning process. Salomon believed that because of these symbol systems one medium differs from another and should be analyzed singularly. He points out that past studies analyze technologies as one entity instead of individual instruments with their own identities. It is for this reason, he observed that symbol systems are more crucial to instruction than the technology of transmission (Salomon, 1974, p. 385). If symbol systems are so important to instruction, then what are symbols and how do they become systems? These symbols that Salomon refers to are, "any objects, movements, gestures, marks, events, models or pictures that can serve as extractable knowledge" (1979, p. 29). Symbols serve as coding elements that have rules and regulations and can be arranged into schemes. This data is transferred to others when the systems are shared through common knowledge or by learning a new system. According to Jerome Bruner and David Olson, "this is how information about the world and information about human activity is used in gaining knowledge" (Bruner et al., 1977-78, p. 2). This information delivered in the form of symbol systems becomes the message. There has been much debate on the definition of message regarding the technology. Symbol systems are an important part of a message, but there are other elements that add to the information.

Marshall McLuhan pondered that there was more to the message then content in his theory about "the medium is the message" (1964, p. 13). His bold theory that it was not content but the medium that was the message created a new perspective on the importance of technology selection. The learning environment should focus on how information is delivered not what the information contains. McLuhan saw the type of technology used as equal or more important than the content. In fact, he believed the technology was the content. Although Salomon refutes McLuhan's stand on the importance of the medium, it seems that they are in partial agreement for at least one reason. If different technologies contain their own inherent symbol systems that make them unique than each medium's message is impacted in differing ways. Thus, part of the medium is the message. At this point, the transmission of technologies becomes important for the very reason Salomon disputes it. Technology utilizes many different symbol systems simultaneously, but each medium has a unique system that is a part of the technology. According to Salomon, it is these symbol systems that are a large part of how learners comprehend messages (1974, p. 405). Gavriel Salomon stressed the importance of interaction between symbol systems, messages, and the individual technology. He stated, "A medium may be more appropriate for the transmission of certain information to a particular learner because it utilizes a symbol system that is isomorphic to the symbolic mode of that learner's thinking" (Salomon, 1974, p. 394). In other words, the learner may share a better understanding of a particular technology's symbol system than various other technologies.

Finally, in the intricate process of technology selection for instruction, stands the learner. According to Salomon, "the question of the learner's abilities, attitudes, patterns of motivation, and the like, becomes of utmost importance" (1974, p. 395). These learners have different levels

of competency and varied goals. Because of these differing levels, it becomes difficult to match one technology with a group of learners. Each learner is not affected in the same manner by each technology. Hence, there is no superior technology for individual learners and one type of technology should not be restricted to one group of learners (Schramm, 1977, p. 61). Thus, cognition of the learner plays an important role in the interaction between the technology and the learner. Salomon observed, "it is difficult to predict what a particular learner will extract from a display, and yet, it is in the overlapping area of the four factors that instructional effectiveness of media is maximized: the broader the overlap, the more specific the medium" (1974, p. 398). Therefore, it is evident that because the learner/user is difficult to strictly define, instruction should encompass many elements to secure the transference of information and the acquiring of knowledge. If the interaction between technology, cognition and learning are so important, then symbol systems alone may not hold the key to acquiring knowledge. Technology must also be rigorously defined and explored as much as symbol systems, cognition, and learning.

The analysis of these theories represents an evolution from a cognitive event to the sequences of instruction. There is more to educational technology than what kind of technology is to be selected. It is the learner that should be the focus of this research. Further, how the learner is going to achieve goals through the aid of technology becomes the instructor's job. As Diane F. Witmer stated in a 1998 study, "it may be useful to integrate the teaching of educational technology into general communication-related courses where theoretical concepts can be applied through electronic interaction" (p. 172). Twenty plus years later in studies on the use of AI technology in education, researchers (Seo et al., 2021; Toumi, 2018; Velander et al., 2023) agree with Witmer's concept that instructional design and focus on the learner are key in how technology is successfully utilized in a classroom. Tuomi et al. stated, "as there may be fundamental theoretical and practical limits in designing AI systems that can explain their behavior and decisions, it is important to keep humans in the decision-making loop" (2018, p. 36). The utilization of technology in college classrooms requires a basis in sound theoretical practice, which has been richly provided by former researchers. Study of these past theories gives new insight into better ways of using technology in education and can help present researchers on how to better utilize new technologies such as AI in the field of higher education.

The implications of this research are that the focus of the instructor is no longer on technology selection alone but must include a thorough understanding of the learner and their constructed knowledge. Artificial Intelligence literacy is helping to make a shift in the field of education from which technology is the best tool for learning to which technology meets the needs of each learning situation. As stated by Sandy Hervieux and Amanda Wheatley (2024), AI literacy is the conscious choice to partake in discourse surrounding AI; it is learning about AI and using technology to better understand its presence in everyday life." (p.6). It is this paradigm shift that is having the greatest impact on in the field of education technology. As the use of AI continues to grow in education, the need for using this technology must be justified through research grounded in proven theories. Otherwise, education will continue to be mired in the endless debate that one "technology" is best, and "that" technology will continue to change as technology evolves. Why reinvent theories when the road for using various technologies has been laid out for present and future researchers? The time has come to build bridges from past roads to new areas of learning by improving AI literacy in college classroooms.

The theorists analyzed all point to the importance of the learner and what each learner brings to the learning event. The process of learning is complicated but manageable when discussed and analyzed to provide a variety of applications to each learning environment. For this reason, it is so important to study theories such as Jean Piaget's theory of cognition and Robert Gagne' and Leslie Briggs' theory of instruction as well as Gavriel Salomon's theories. It is the process of learning that is the key to aiding students in their quest for knowledge and it is the duty of the instructor to make that process easier using proven models in Artificial Intelligence literacy.

This study reviewed groundbreaking past research theories to observe if these theories are still having any influence on the use of technology in today's college classroom. After reviewing these theorists and identifying their most influential models, the analysis focused on the research being conducted on the latest technology being used in college classrooms. Artificial Intelligence is the new technology now being utilized in classrooms across the world and has even been called "the new electricity" (Tuomi, 2018). AI is already impacting multiple fields including business, supply chain, media, and the auto industries to just name a few but the field that this technology will perhaps have the greatest impact on is education. Research on the use of AI literacy in education is just beginning and most of the studies are on using artificial intelligence literacy at the K through 12 level (Cabrera et al., 2018; Ng et al., 2023; Velander et al., 2023). There are limited studies that focus on the use of AI literacy in college classrooms and most of the learners in many of the studies (Laupichler et al., 2022; Southworth et al., 2023) are from the STEM fields with only a few analyzing the general student population. There seems to be a lack of academic research on AI literacy in college classrooms and is why this study is focusing on AI Literacy in higher education. The purpose of this study is to conduct a critical review of the use of artificial intelligence literacy in college classrooms by using foundational theories from the past. During this investigation any patterns that emerges from the major studies in AI literacy in higher education research will be identified and analyzed.

Methodology

The past theories and models covered do not just focus on the use of technology but on the learning process. Therefore, reviewing the current research on the use of technology in education can help shed light on if the learning process is still the focus of technology literacy in education or has the latest technology taken over the instructional process. In this phase of the study, a critical analysis of the current research in AI literacy in higher education was conducted. Both academic and Google Scholar data bases were used to find research, over the past three years, that studied the use of AI literacy in higher education. One hundred studies were collected and then narrowed down to 13 studies that focused on AI literacy in higher education. Most studies (Chiu et al., 2023; Dai, et al., 2020; Markauskaite et al., 2022; Velander et al., 2023) of AI literacy in education were on the K through 12 system and very few focused on the higher education level. The studies that were centered on higher education analyzed AI literacy at the graduate level (Xu et al., 2021) leaving very few studies that analyzed the use of AI literacy at the undergraduate level. The sample became even smaller if non-STEM undergraduate programs were reviewed so for the purpose of this critical analysis, studies that focused on AI literacy in higher education at the undergraduate level were analyzed. These filters left 13 articles to be

reviewed and answer the research questions: What are the practices or criteria used in artificial intelligence literacy in college classroom? Is current artificial intelligence literacy research based on past theories and/or models or are new models and theories being developed?

This study also included narrowing the research to those written in English and had followed rigorous peer reviewed academic standards. Articles that were based on the popular culture use of AI or how-to articles were eliminated from being reviewed because most were opinion based with minimal evidence provided to support the use of AI Literacy in college classrooms. These studies selected for review came from a variety research fields but the majority are from the Computer and Education Artificial Intelligence Journal, the Journal of Education and Learning Innovation, the Journal of Educational Technology Higher Education, and the Education and Information Technologies Journal. The studies selected for review included research where artificial intelligence literacy played a key role in the learning process. This study used critical analysis based on the methodology used in Robert Stake's 2010 book titled, "Qualitative Research: Studying How Things Work". Stake discussed how a literature review can be conducted in a systematic way to glean important and evidence-based information from data collection (p. 115). However, a literature review is more than just data collection, as Willy Lima and Enid F. Newell-McLymont's stated in their 2021 article on qualitative methods, "literature review is an attempt to bring together writings on diverse matters related to the coming study's phenomena" (p. 192). Thus, a critical analysis such as a literature review can help a researcher bring both data and context to complex problems. The studies that set clear rules when using AI Literacy, laid out general norms and expectations as well as specified learning outcomes met the criteria to be critically reviewed for this study (Lima & Newell-McLymont, 2021). In addition, these 13 studies regularly came up when the search string "Artificial Intelligence Literacy in higher education" was searched as the key term in academic and Google Scholar databases.

To critically analyze these studies a clear definition of AI Literacy is needed. Webster's dictionary defines AI as "the capability of computer systems or algorithms to imitate intelligent human behavior" and defines literacy as "the understanding and information gained from being educated" (online: http://www.merriam-webster.com/dictionary, October 22, 2024). Thus, artificial intelligence literacy is the ability of individuals to use computer systems/algorithms that imitate human behavior to gain knowledge. AI literacy research refines the definition even further, a Ng et al. 2021b study breaks it down into four concepts of: knowing and understanding AI, using and applying AI, evaluating and creating AI, and AI ethics. While a 2020 Long and Magerko study defines AI literacy as a set of skills that enable individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool in various settings (Long & Magerko, 2020; Faruqe, et a., 2021). For the purposes of this study AI Literacy will be defined as individuals using AI technology to gain knowledge in ethical and creative ways in various educational settings.

Results

The experimental articles analyzed students from diverse study backgrounds taking AI literacy courses at the undergraduate level. These studies looked at the use of AI literacy in various educational settings in undergraduate courses. Kong et al., 2021 study designed, implemented,

and evaluated a seven-hour AI literacy course for 120 student volunteers from first to fourth year in an undergraduate program. In Lee's et al., 2021a, study 45 non-major undergraduates were studied to see if these students perceived AI technology to be difficult and if more efficient AI education was needed. Lee et al. follow up study (2021b) analyzed 30 non-major undergraduates to see if AI literacy was appropriate for this learner's level, applied it to the classroom and measured the impact on AI ethics. Lin et al., 2021 article created a three-week AI literacy learning activities for 328 non-engineering freshmen from various majors at a university in Taiwan (p.226). Wang et al., 2021 studied 311undergraduate in-service teachers at a university in China and analyzed how teachers' intention to adopt AI tools in their classes played a role in enhancing learning performance.

All the experimental studies had positive outcomes with Kong et al., 2021 results showing that participants made significant progress in understanding AI concepts and felt empowered to work with AI (p. 10). Lee et al., 2021a results showed that AI technology may be used relatively easily, and the implementation expanded by using AI learning models. Lee et al., 2021b results verified there was a positive change in the perception of the artificial intelligence ethics through the proposed AI literacy educational program (p. 52). Lin et al., 2021 results showed a positive correlation between students' AI literacy and their awareness of AI ethical issues (p. 235). This article made a connection between learning activities and different aspects of AI learning and suggest this method could be used to help general education courses improve AI literacy (p. 226). Wang et al., 2021 results showed, "that teachers' perceived usefulness of AI technologies and their attitude towards AI technology-supported teaching would have positive effects on their adoption behavior" (P. 125). These studies also found that there was not enough research being conducted at the college level (Kong, et al., 2021; Lee et al. 2021a & 2021b) and that the ethical issues surrounding the use of AI in higher education needs to be better evaluated and understood. Including how to properly use AI technology in higher education and how AI literacy can help improve understanding the issues surrounding copyright and plagiarism.

The literature review articles analyzed hundreds of studies over decades from a variety of disciplines that covered the use of AI literacy at the undergraduate level. Chen et al., 2021 study reviewed 45 of the most influential AI educational studies. Including two with the most citations. Long's et al., 2020, study reviewed 150 papers to detail AI literacy competencies for learners and create design models to be used in instructional design of AI literacy in classrooms. Ng et al. 2021a study analyzed 18 peer-reviewed articles that proposed four aspects of: know and understand, use, evaluate, and ethical issues; for fostering AI literacy. This exploratory review was conducted to create a foundation to define, teach and evaluate AI literacy. A follow up study by Ng et al. 2021b analyzed 30 articles using Bloom's Taxonomy and expanded on the four aspects of fostering AI literacy in higher education by adding "apply and create" to their model. Thus, the updated model is: know and understand, use and apply, evaluate ad create, and ethical issues.

The literature reviews revealed several gaps in AI literacy in higher education research such as Chen et al., 2020 study that showed little work had been conducted to bring deep learning technologies into the educational contexts. This review also disclosed that the field needed to closely incorporate the application of AI technologies with educational theories. Long et al.,

2020 review developed 17 competencies from: (1) Recognizing AI, to the (10) Human role in AI, to (17) Programmability. These competency steps help instructors and learners have a framework of achieving expertise in AI literacy. In addition, this same study developed 15 Design Considerations from: (1) Explainability, to (8) Critical Thinking, to (15) Low Barrier to Entry. These Design Consideration steps help the instructor better plan AI literacy courses to improve learning outcomes and skills in using Artificial Intelligence in college classrooms. Ng et al., 2021a review found that, "educators should not only teach students to build machine learning models, but also guide them on how to implement these emerging technologies ethically" (p. 507). Ethical issues of using Artificial Intelligence in college classrooms appeared multiple times throughout the literature reviews. The discussions centered around fairness, accountability, and inclusion because the use of AI in education may include biases based on how the tool was programmed. In Ng et al., 2021b follow up study the researchers found, "to advance the AI literacy field, priority needs to be placed on proposing definitive frameworks to guide educators to create lesson designs with appropriate pedagogies, learning artefacts and assessment criteria" (P. 9). These frameworks or models need to help an instructor design content using AI that does more than help the learner gain knowledge about a specific subject but also helps the learner understand if the content is factual, thus making the learner AI literate. These studies also found that there was not enough research being conducted at the college level (Chen, et al., 2020; Long et al. 2020; Ng et al., 2021a & 2021b) and that the ethical issues surrounding the use of AI in higher education needs to be better evaluated and understood.

The non-experimental and exploratory articles analyzed students and faculty from the fields of engineering and informatics taking AI literacy courses in-person and online at the undergraduate level. These studies investigated the use of AI literacy in various educational settings including in a blended learning model course and an online asynchronous course. Fathahillah et al., 2023 study analyzed 156 participants from the Department of Informatics and Computer Engineering, Faculty of Engineering at Makassar State University who had taken web programming courses (p. 567). The purpose of this non-experimental quantitative analysis was to determine the literacy of artificial intelligence in a blended learning model by observing the dependent variable (AI) to look for a cause in the study. Seo et al., 2021 studied 23 science/technology undergraduates and instructors and analyzed how learner-instructor interactions impacts students' satisfaction and learning outcomes. This exploratory study focuses on, "identifying how students and instructors perceive the impact of AI systems on their interaction" by identifying "any gaps, challenges, or barriers preventing AI systems from achieving their intended potential and risking the safety of these interactions" (p. 1).

The non-experimental study (Fathahillah et al., 2023) revealed that the advantages and disadvantages of AI literacy had both a positive and significant effect on data security and privacy. The results showed that both instructor and student should be better equipped to protect sensitive information by utilizing ethical and legal guidelines when using AI literacy in a blended college classroom. This analysis also disclosed that AI literacy in a blended learning model in higher education is a complex and multifaceted topic (p. 567). The use of AI literacy in a college classroom that combined in-person instruction with online learning activities created a flexible and interactive learning environment that not only personalized the educational experience but allowed the learner to move at their own pace and receive timely feedback (p. 566). This study

also discussed that ethical issues needed to be considered and addressed when using AI technology in college courses.

While the exploratory study (Seo et al., 2021) showed, "students and instructors expect that AI systems will benefit learner-instructor interaction in online learning in terms of improving the quantity and quality of communication, enabling just-in-time personalized support for students at scale, and giving them a feeling of improved connectivity" (p. 16). Thus, the impact on the learner-instructor interaction in the online college class that utilized AI technology improved the learning environment. However, as it improved the learning environment, both students and instructors also perceived some problems such as: communication was timely, but they were concerned with AI-based misunderstandings; they valued just in time, personalized support but feared AI limited independent learning; they also valued social interaction cues provided by AI but were uncomfortable with loss of privacy and excessive data collection (p. 16). This study also discussed that ethical issues such as the invasiveness of AI technology needed to be considered and addressed when using this technology in college courses. Thus, making AI literacy at the higher education level ever more important.

The theoretical framework and model development articles analyzed research from a variety of disciplines that covered the use of AI literacy in higher education. Hwang et al., 2020 study defined the role of AI in education as systems that simulate human intelligence to make inferences, judgments, or predictions and then the study created a framework for using AI in different learning and teaching settings. The study focused on applying AI to teaching and learning design by listing ten areas of AI research that need further investigation. Southworth et al., 2023 study developed a model for using AI literacy across the curriculum at the University of Florida impacting six thousand students in two hundred courses. Data on the student learning outcomes will be collected annually by the curriculum team who work with university managers to update the SLO's and program goals. AI courses were developed to ensure that courses from all AI literacy topics are accessible to all undergraduate students in each college. The metrics to assess this goal are the number of curricular offerings within each AI area by college and undergraduate student enrollment in AI courses in each area by college (p. 9). This article based their model on Ng et al., 2021b model: knowing and understanding, using and applying, evaluating and creating and AI ethics but added the category "Enabling AI" to the UF model. This study built and supported the model they developed with several major papers from AI literacy research including articles (Chen et al., 2020; Hwang et al., 2020; Ng et al., 2021a/2021b) being critically analyzed for this study. The results of the use of the model at the university of Florida will not be available for several years since they are collecting data based on the 4-year cycle of undergraduate programs.

The theoretical study (Hwang et al., 2020) created a guideline for researchers with backgrounds in both the computer and education fields to conduct studies in Artificial Intelligence education. They revealed several gaps in AI in education research, which includes higher education, that needed to be addressed including listing these ten areas:

- "Development of AI-based learning models or implementation frameworks,

- evaluation of the performance and experience of the students learning with existing AI systems,
- investigation of the effectiveness of AI-based learning systems from various perspectives,
- reexamining and redefining the existing educational theories by considering different roles of AI in education,
- proposing innovative AI-supported learning or assessing strategies. Incorporating new technologies into educational settings implies new concepts of learning design,
- reexamining and reconsidering the way of using existing learning tools in AI-supported learning content. Like most technology-enhanced learning contexts, employing effective learning tools or strategies,
- big data analytics for large-scale data sources in learning systems and educational contexts,
- developing large-scale learning systems: The large-scale learning systems aim to facilitate the quality learning experience for millions of learners with scalable technologies,
- developing ethical principles and practices for employing AI technologies and applications in education: Use of AI in education can not only promote the learning effectiveness and augment the human intelligence during the learning process, but may also raise potential ethical issues,
- human-AI collaboration: AIED has traditionally proposed and evaluated the ways to tutor and support students. Concepts of fading scaffolds and zone of proximal development are used to guide the extent to which AI-driven support should be offered to the learners" (p. 3-4).

This list displays the need for more research in the use of AI in education by discussing the lack of studies in measuring the effectiveness of AI-based learning systems to the need for assessing learning strategies to developing ethical principles and practices for using AI in educational settings. This article set up the framework for these same areas to be analyzed at the higher education level as well.

The article (Southworth et al., 2023) reveals how the researchers developed an innovative model using AI literacy across a university's curriculum by designing it to be engaging with different approaches and learning styles to transform higher education through a transdisciplinary approach while making is accessibile across all colleges and majors campuswide (p. 9). The model is based on Ng et al., 2021 AI literacy model and must align with the university's student learning outcomes, which include content knowledge, critical thinking, and communication. These researchers' see an artificial intelligence paradigm shift occurring in education and view AI literacy as the cornerstones of innovative college curriculum. The new and innovative model fosters interdisciplinary engagement while preparing college students for today and tomorrow's jobs. The UF AI literacy model is based on Ng et al., 2021b model but added another area making it five categories which include: Enabling AI through knowledge and skill development; Know and Understanding AI through the basic functions and use of AI applications; Use and Apply AI by applying knowledge, concepts and application in different scenarios; Evaluate and Create AI through higher-order thinking skills with AI applications; and AI ethics through human-centered considerations such as fairness, accountability, transparency and safety (p. 7). In

addition, four categories of the model must have more than 50% of AI content in a course except for the Enabling AI category, which can be between 10% to 49% AI content based. In other words, courses across the curriculum need to be emersed in AI content regardless of the topic being taught to meet the criteria set up by the UF AI literacy model. The data being collected annually is being used to update and modify student learning outcomes and across curriculum goals. This framework and model development studies can be used to help an instructor design content for multiple areas using AI that also helps the college level learner become AI literate. These studies also found that there was not enough AI research being conducted at the college level (Fathahillah et al., 2023; Hwang et al., 2020; Southworth et al., 2023) and that AI ethical issues impact its use in higher education.

Discussion

The purpose of this study was to analyze if past educational theories and models are being used in current AI literacy research? The critical analysis of this research confirmed that past educational theories are being used even if they are not overtly identified. Several of the studies used models or identified models and theories that should be used such as Southworth et al., 2023 model that is based on Ng et al., 2021b model. Both models appear very similar or are at least an extension of Gagne' and Briggs original 1974 model. The latter has five phases of information processing and learning including: intellectual skills (aid the student in carrying out symbol-based procedures), cognitive strategies (aid the learner in cognitive processing), information (facts are organized and stored in memory), motor skills (the physical activity required for purposeful actions), and attitudes (modify an individual's choices of action) (Gagne' et al., 1974, p. 51). While the new AI literacy model developed in the Southworth et al., 2023 study also has five categories that includes: enabling AI through knowledge and skill development; know and understanding AI through the basic functions and use of AI applications; use and apply AI by applying knowledge, concepts and application in different scenarios; evaluate and create AI through higher-order thinking skills with AI applications; and AI ethics through human-centered considerations such as fairness, accountability, transparency and safety (p. 7).

Table 1 displays how the phases and categories of the past and current models both cover the same cognitive processes. Gagne' et al., 1974 model's first phase in the learning process is through students gaining intellectual skills, while Ng et al., 2021b model's first category of AI literacy is the student gaining knowledge and understanding through basic functions and use of AI applications and this lines up with Southworth et al., 2023 model's second category of their model. Gagne' et al. 1974 model then moves to the next phase of cognitive strategies that help the student learn and process information, while Ng et al., 2021b model's first category covers this same process of learning, and Southworth et al., 2023 covers this cognitive development in the first category of their model. In the third phase of Gagne' and Briggs model information and facts are organized into the student's memory, while this area of learning is covered in Ng et al., 2021b AI Literacy model's third category and Southworth et al., 2023 AI literacy mode's fourth category. The fourth phase of instructional design theory focuses on motor skills and physical activity required to demonstrate the student has learned or is in the process of learning, while this area is covered in Ng et al., 2021b model's second category and Southworth et al., 2023 model's

third category of their AI literacy models. The final phase of the ID model looks at the students' attitude and how learning has modified that individuals' choices of action based on the learning that has taken place. The current AI literacy models' final categories in Ng et al., 2021b model's fourth category and Southworth et al., 2023 model's fifth category focus on the same area of cognitive processing but instead of labeling it attitudes calls it AI ethic and defines this area as human-centered considerations such as fairness, accountability, and safety. One might argue that both the past model and current models are talking about the same aspect of learning, because attitudes are human-centered considerations.

Table 1: 1974 Gagne' & Briggs ID Model and 2023 Southworth et al. & 2021b Ng et al. AI Literacy models

Intellectual skills, aid the student in carrying out symbol-based procedures	Know and Understanding AI through the basic functions and use of AI applications. (Ng 1 & Southworth 2)
Cognitive strategies, aid the learner in cognitive processing	Enabling AI through knowledge and skill development. (Southworth 1)
Information, facts are organized and stored in memory	Evaluate and Create AI through higher order thinking skills with AI applications. (Ng 3 & Southworth 4)
Motor skills, the physical activity required for purposeful actions	Use and Apply AI by applying knowledge, concepts, and application in different scenarios. (Ng 2 & Southworth 3)
Attitudes, modify an individual's choices of action	AI Ethics through human-centered considerations such as fairness, accountability, transparency, and safety. (Ng 4 & Southworth 5)

There is definite cross over between the categories and different phases of the Gagne' et al., 1974 model but the current models (Ng et al., 2021b; Southworth et al., 2023) also take the older basic instructional design model and expand on it by adding the AI literacy perspective. What is confusing is why aren't current researchers recognizing that these past theories are supporting the new AI literacy models and are proven theories that have successfully helped improve student learning outcomes for decades (Gagne' 1977 & 1986; Gagne' et al., 1974; Gagne', Briggs et al., 1988). AI literacy researchers do not have to keep reinventing the wheel with every new technology used in higher education. Creating new models with every new technology developed takes more time and the field of AI literacy research needs to fill research gaps as soon as possible. Most if not all the studies (Chen et al., 2020; Kong et al., 2021; Lee et al., 2021a/2021b; Lin et al., 2021; Long et al., 2020; Ng et al., 2021a/2021b; Wang et al., 2021) analyzed discuss a need for more AI literacy research at the college level that measures the effectiveness of using AI literacy in universities' classrooms that cover multiple areas of study.

Thus, utilizing instructional design models such as Gagne' and Briggs and combing it with Gavriel Salomon's theory that each medium has its own inherent symbol system that impacts content as well as focusing on Piaget's cognitive development theories would create a strong foundational AI literacy model. In fact, these researchers would have a model that looks very

similar to the one that Southworth et al., 2023 developed for implementing AI literacy across the curriculum at the University of Florida. This finding would suggest that review and use of more educational technology and design theories from the past could expedite and enrich current AI literacy research (Hervieux et al., 2024; Fathahillah et al., 2023; Hwang et al., 2020; Lee et al., 2021b; Lin et al., 2021; Seo et al., 2021) in higher education. Thus, this confirms one of this study's research questions, that artificial intelligence literacy research in college classrooms are using practices and criteria based on past theories and new models and theories are also being developed from the groundbreaking theorists discussed in this study.

The findings from this critical analysis study are that college instructors need to use more AI literacy in their courses across disciplines to give students basic knowledge in the use and function of Artificial Intelligence (Chen et al., 2020; Fathahillah et al., 2023; Lee et al., 2021b; Lin et al., 2021; Southworth et al., 2023). The instruction should be designed to engage the learner through several teaching methods including lectures, demonstrations, case studies, in-class exercises, programming assignments, and projects. (Kong et al., 2021; Xu et al., 2021). The more performance based the activities the more the students' learning outcomes improve, and these assignments help to limit the misuse of AI technology in college classrooms and thus improve AI literacy (Lee et al., 2021a & 2021b; Long et al., 2020; Seo at al., 2021). Finally, applying a proven AI literacy model to the implementation, practice, assessment, and ethical implications of using AI in college classrooms can help create more AI literate students at the higher educational level.

Limitations

The limitations of this study include the small sample of research that was reviewed for this analysis. However, AI literacy in higher education research is in the early stages and with new studies being conducted, a more robust analysis of the research can take place. There is an urgent need for more quantitative and qualitative studies to take place for the field to grow and be able to yield results that can be applied universally. There is also a need for more empirical research to build a robust and accurate understanding of preconceptions about AI literacy and what the best practices are for teaching AI literacy to non-technical students (Long et al., 2021). Another limitation was most of the studies were literature reviews and/or case studies with some experimental research being conducted. Finally, all the studies reviewed had small sample sizes or were limited to one university's student population. More AI literacy research in higher education needs to use larger student populations sampling so the results can be better supported by factual data.

Suggestion for Future Studies

To improve the quality of the research in AI literacy in higher education, more experimental studies on using AI in higher education need to be conducted. These studies need to use larger sample sizes, so the results are more generalizable to the field of higher education. Most of the research (Chen et al., 2020; Lin et al., 2021; Ng et all., 2021) reviewed suggest multiple topics that need to be undertaken (evaluating students' performance learning with AI systems, Human-AI collaboration, and developing ethical AI literacy principles and practices) and yet there was

very little research demonstrating that these studies are being performed. Future researchers should also investigate the use of educational theories, learning strategies and methods that could be used to enhance AI literacy in higher education. More studies need to include larger sample sizes that are not just STEM-based but are from multiple areas of study and universities. Case studies are very valuable to advancing research but should not be the dominate methodology used in AI literacy research at the higher education level. Several studies (Hwang et al., 2020; Long et al., 2020; Southworth et al., 2023) reviewed developed models and these models need to be tested by conducting research that measures the learning outcomes with surveys as well as participant interviews to get a better picture of which models are working and which are not. Future research also needs to look at the ethical issues surrounding the use of AI in higher education and how AI literacy can play a role in creating ethical guidelines for its use in college classrooms.

Conclusion

Most of the studies (Chen et al., 2020; Lin et al., 2021; Long et al., 2020; Ng et al., 2021a/2021b; Wang et al., 2021) discussed that more educational theories need to be utilized to help improve AI literacy in higher education. They also found that AI literacy research in higher education is limited and needs to be expanded in many areas including: Developing more AI-based learning models, investigating the effectiveness of AI-based learning systems, employing effective AI learning tool and strategies, evaluating Human-AI collaboration, and developing ethical principles and practices of using AI technology in college classrooms (Kong et al., 2021; Hwang et al., 2020; Ng et al., 2021a/2021b). One of the most stunning findings from this analysis is how little research is being done on the use of AI literacy at the higher education level. In addition, this critical analysis also identified an immediate demand to conduct more studies that look at evidence-based data such as student learning outcomes and if educational programs' goals are being met. It is difficult to assess if AI literacy is indeed improving in higher education beyond these studies since their sample sizes are quite small, and yet the need to improve AI literacy at the college level grows each day.

The need for AI literacy is not going away and AI is being utilized more and more in the various fields of art, business, education, engineering, health, and science, etc. It is changing and will continue to change how people live their lives, and higher education needs to better prepare students for their fields as well as help make them more literate about the information that AI provides. This is why AI literacy research in higher education is so vital because without more quantitative and qualitative studies on larger student populations the ability to create more AI literate human beings diminishes, and the ability to be manipulated and misinformed increases.

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Empowering Critical AI Literacy through Sociology of Knowledge: Pedagogical Strategies for Undergraduates

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Abstract

This article proposes pedagogical applications to enhance AI literacy for undergraduates through the lens of the sociology of knowledge. These applications are designed to help students navigate the risks and benefits of AI-based tools while ensuring both effective learning and academic integrity. The intended AI literacy competencies include critical thinking, ethical awareness, and digital literacy. To develop these competencies, the article proposes forming diverse and interdisciplinary student groups, training students to use valid and reliable data to evaluate AI-generated results and encouraging creative engagement with learning materials through group activities, debates, arts, and role-playing.

Keywords: Critical AI literacy, pedagogical applications, sociology of knowledge

Introduction

Before the rapid proliferation of artificial intelligence (AI)-based tools, particularly with the commercialization of ChatGPT by OpenAI in November 2022, debates about the promising capabilities and threatening perils of AI had already surfaced. These discussions encompass both critical reflections on AI risks and optimistic perspectives on its advantages. Bostrom (2014) articulated grave concerns regarding AI's potential to surpass human intelligence, leading to AI "superintelligence" and potential loss of "human control" over AI systems. Conversely, Russell and Norvig (2016) delineated numerous applications of AI in their comprehensive book, highlighting the potential benefits derived from its use. Additionally, scholars have delved into the intricate aspects of imbuing machines with "mental qualities" through machine learning techniques, as articulated by the "father of artificial intelligence", McCarthy (1979).

Critical AI literacy is essential to address both security risks and intellectual challenges. On the security front, there is a critical need to assess AI advancement and its implications on job security due to automation (Hutter and Hutter, 2021), there are serious concerns over the potential unreliability of AI-based security tools which could lead to AI-driven warfare (Cummings,2017;Putz,2023), and there is a global need to evaluate cybersecurity vulnerabilities caused by the spread of AI-based online tools (Wiafe et al., 2020). On an intellectual level, the threats posed by AI include the dissemination of AI-generated misinformation (Partadiredja et al., 2020), issues of algorithmic bias (Kordzadeh & Ghasemaghaei, 2022), moral biases (Keles, 2023), and the opacity surrounding AI development and deployment (Seizov & Wulf, 2020).

This paper aims to enhance AI literacy in undergraduate education by introducing college students to the nature and definition of knowledge i.e. information, drawing on sociology of knowledge to be able to

evaluate the reliability of AI-generated information. This is done by incorporating low-challenge activities and role-playing for fun purposes, which can help students build a community of solidarity and support. Knowledge without a strong sense of community can be fruitless. Community activities are also essential for enhancing group dynamics and establishing group norms to maximize engagement with the learning activities.

The focus on college-level education is justified by the need to prepare students for the growing academic and professional challenges intensified by AI. These include the spread of inaccurate AI-generated information, unethical use of AI in completing academic assignments, and the need for students to understand how AI will affect their future job prospects. To address these AI related challenges, the paper proposes pedagogical applications to equip college-level students with AI literacy skills, so they can become informed and responsible participants in an AI-driven world. AI literacy, therefore, refers to equipping students with the conceptual understanding, practical skills, and ethical compass to navigate the misuse of generative AI, its biases, and to responsibly use AI as a technological tool in accordance with social and moral expectations.

Before delving into these pedagogical applications to empower AI literacy among undergraduate students, it is important to acknowledge the breadth of these activities and their respective fields of study. Therefore, the focus of AI literacy in this paper is to empower undergraduate students with AI literacy tools to safeguard themselves against misinformation and bias and develop moral code to navigate AI technologies. To achieve this, I propose applied learning activities that highlight strategies to ensure student engagement by forming diverse and interdisciplinary teams. Additionally, I suggest debriefing sessions to extract key lessons from the learning activities, which will empower students' critical AI literacy.

AI-Driven Tools in Higher Education: Risks, Benefits, and the Imperative for AI Literacy

The Internet provides vast access to information, yet it also leads to information loss, distortion, and misappropriation. This phenomenon is compounded by the powerful capabilities of generative AI tools, making it increasingly difficult to discern reliable information. Furthermore, the proliferation of educational ChatBots like ChatGPT and Gemini (formerly Bard) has not been accompanied by adequate preparation for learners, particularly undergraduate students, to critically engage with these technologies.

Numerous studies across different regions have highlighted both the risks and potential benefits of AI-driven educational tools in higher education, which impact students' learning experiences (Strzelecki, 2023; Kumar & Raman, 2022). It is worth emphasizing that the exploration into the risks and potential benefits of using AI tools among students in higher education gained momentum after the widespread adoption of generative AI tools. According to Crompton and Burke (2023), "the number of publications in 2021 and 2022 increased almost two to three times compared to previous years.". Emerging research on AI impact on higher education reflects a responsive approach rather than a preemptive approach to assessing AI tools. This responsive approach is justified by the urgency prompted by the commercialization of AI tools, led by platforms like ChatGPT. This therefore urges educators to critically evaluate these technologies to ensure meaningful learning and valid assessment practices.

With the advent and rapid rise of generative AI usage among undergraduate students, there have been increasing calls to address how generative AI threatens traditional teaching and assessment methods in higher education. These calls emphasize that the focus of digital literacy must shift towards equipping students with the necessary critical thinking skills, ethical conduct, and active intellectual engagement to navigate generative AI. (Walczak & Cellary, 2023).

Within college education, any proposed literacy skills and ethical considerations in the age of AI must be grounded in an examination of how undergraduate students engage with AI technologies, as well as the risks and benefits posed by these technologies. For instance, research by Li (2023) demonstrates that students' attitudes and actual use of AI-based systems in Chinese higher education are significantly influenced by factors such as perceived usefulness and ease of use. However, challenges persist, as evidenced by Ghotbi and Ho's (2021) identification of "limited moral awareness" among students in the Japanese higher educational milieu, amidst widespread AI-based educational tool adoption. Similarly, studies conducted in the US context reveal how students use AI tools to enhance review strategies post-learning, particularly in disciplines like public health (Lee & Chen, 2022). Additionally, research from Croatia illustrates students' utilization of ChatGPT for tasks such as idea generation and proofreading in written assignments (Črček & Patekar, 2023)

Several educational strategies aim to enhance AI literacy by improving skills in computational thinking, digital literacy, and programming. These skills involve understanding and applying the fabrics of algorithmic and data thinking in the development and critique of AI tools (Liu & Xie, 2021). Additionally, efforts include developing AI-empowered educational tools to bridge the global digital divide, ensuring equitable access and benefits from AI technologies (Eguchi, 2021). From a teaching standpoint, Kong et al (2021) propose an AI literacy course to educate about technical knowledge in AI development, covering topics such as programming and machine learning (Kong et al., 2021).

While variations on AI use exist across research contexts, the common thread of AI usage underscores a global urgency to cultivate AI literacy within higher education worldwide. This imperative transcends boundaries, emphasizing the need for concerted efforts to foster the following AI literacy competencies: critical thinking, ethical awareness, and digital literacy.

Figure 1 AI Literacy Competencies
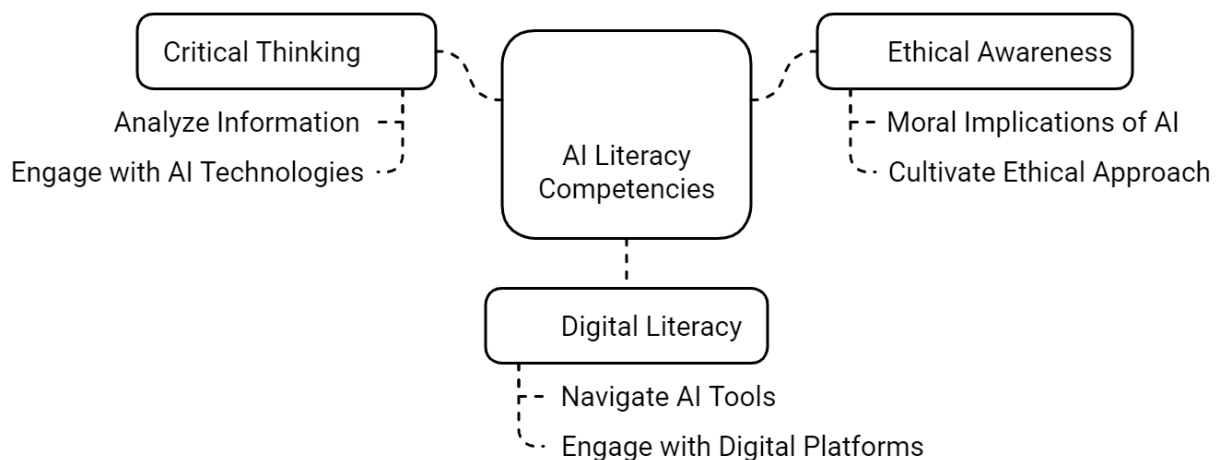
As is known, AI literacy is a broad field that requires input from multiple disciplines, given that the risks of AI technology encompass various complex social, political, and technological areas. For this reason, from a teaching standpoint, AI literacy can be approached from different perspectives depending on the academic discipline, learning outcomes, and the specific risks and benefits associated with that discipline. Within the social sciences, Figure One reflects key literacy competencies informed by insights from the sociology of knowledge. These skills are threefold. First, critical thinking, which involves examining AI-generated information, such as biases and the role of AI technology in either benefiting society or creating

problems like the digital divide or disparities between the "haves" and "have-nots." Second, ethical awareness, which refers to the principle that just because we can do something with AI doesn't mean we should—especially if it affects privacy, confidentiality, or violates academic integrity. Third, digital literacy, which encompasses the skills needed to question the authenticity of digital outputs, such as fake videos, AI-generated voices, and AI-created images. The development of the proposed AI literacy competencies, in figure one, will be connected to the applications of sociology of knowledge.

**Leveraging the Sociology of Knowledge for AI Literacy**

The sociology of knowledge has significantly enhanced our comprehension of the interplay between scientific pursuits and socio-political institutions. Pioneers in this field have approached this interaction from diverse perspectives. For instance, Karl Mannheim delves into the social construction of knowledge, illustrating the robust connection between knowledge formation and prevailing political systems (Mannheim, 1936/2013). As articulated by Mannheim (1936/2013) more than 80 years ago, "the sociology of knowledge has set itself the task of solving the problem of the social conditioning of knowledge by boldly recognizing these relations and drawing them into the horizon of science itself."

Building upon Mannheim's groundwork, Berger and Luckmann (1966) proposed a structured framework elucidating how knowledge is shaped within sociopolitical frameworks and through processes of legitimation, transforming a notion into an accepted fact. Similarly, Michel Foucault's insights on power dynamics in relation to knowledge underscore how power structures influence what is included or excluded from the realm of knowledge (Foucault, 1969).

The sociology of knowledge offers valuable conceptual and methodological perspectives on how AI shapes our social understanding of reality. Below, we will apply some of these perspectives by using pedagogical activities. It's important to highlight that our approach to AI literacy, drawing from the sociology of knowledge, prioritizes practical application (experiential learning) over theoretical exploration (focusing solely on theoretical and conceptual origins of sociology of knowledge). This emphasis is justified by the diverse disciplinary backgrounds of undergraduate students, requiring a program that meets their specific learning needs. However, for students specializing in fields related to the sociology of knowledge, a deeper dive into the historical and theoretical underpinnings of this discipline can be extremely enriching.

Below are three pedagogical applications to delineate how students can learn and apply experientially the sociology of knowledge to engage critically with AI-based tools. The applications below will cover the abovementioned tenets of sociology of knowledge by applying them on AI as put in figure 1 below: a) AI and social construction of reality, b) AI discourse and power dynamics, and c) Contextualizing AI within social structures.

Figure 2 Tenets of Sociology of Knowledge and AI

AI and Social
Construction of

AI discourse and
Power Dynamics

Contextualizing AI
within Social
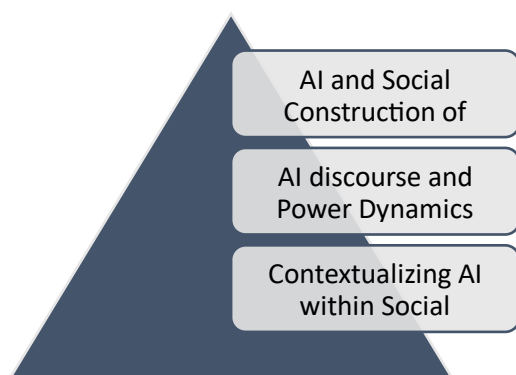
First Application on AI and Social Construction of Reality

In this application, using role-playing scenarios, students will engage in testing the predominant types of knowledge embodied by AI tools, such as ChatGPT. For instance, in diverse student groups, participants will investigate ChatGPT's efficacy in generating knowledge across various native languages using prompts in different languages. This exercise aims to illuminate language biases inherent in AI educational tools, highlighting the influence of underlying data sets. Moreover, this activity unveils cultural biases inherent in AI tools, particularly considering their origins primarily within Western knowledge hubs. Expanding on this theme, students can explore different manifestations of AI biases. These include:

- AI and social media: Analyzing how AI algorithms influence users' ideological inclinations in social media platforms.
- AI and automation: Assessing potential hazards, such as those encountered when AI systems are responsible for driving vehicles.
- AI and healthcare diagnosis: Examining the limitations of AI systems in accounting for health conditions prevalent among marginalized groups.
- AI and news creation: Investigating the role of AI in news generation and the potential consequences, including the proliferation of fake news.
- AI and Global Political Conflicts: Students will have the opportunity to use AI tools to generate information about global conflicts. This activity aims to uncover any biases that AI may have regarding specific global or regional conflicts.

A debriefing suggestion is to discuss, following students' engagement with an AI tool for information generation, how the activities concerning AI biases shed light on the impact of limited diversity among stakeholders in AI development. Additionally, these discussions can explore how biases in the datasets used contribute to a skewed construction of knowledge that fails to capture the intricate nature of global knowledge systems, including indigenous types of knowledge.

The exclusion of indigenous knowledge leads to a biased and flawed social construction of knowledge, where certain forms of knowledge are valued while others are marginalized. For example, Western frameworks dominate discussions on what constitutes a "good life" or a "good society," which excludes indigenous perspectives that emphasize communal well-being, harmony with nature, and spiritual balance. For example, In the field of environmental conservation, indigenous knowledge about sustainable land management practices, such as the use of controlled burns by Native American tribes to maintain forest health, is frequently overlooked in favor of industrial approaches. This marginalization

results in incomplete understandings and ineffective policies that fail to address the diverse realities of different communities.

Generative AI further exacerbates this biased and flawed construction of knowledge by replicating and amplifying the dominant knowledge systems embedded in the data it is trained on. To connect the use of generative AI and social construction of knowledge, the table below highlights how the literacy competencies mentioned in figure 1 can be improved in light of social construction of knowledge:

Figure 3 AI Literacy and Social Construction of Knowledge

Skill	Description	Development in Light of AI and Social Construction of Knowledge
Critical Thinking	The ability to analyze and evaluate information objectively.	- **Refining AI-generated content through prompt engineering**: teach learners to practice developing unbiased prompts to generate more accurate and reliable AI content. This is a good skill to develop asking good research questions ⸺ **Evaluating AI outputs**: encourage students to critically assess the content produced by generative AI, questioning the assumptions, biases, and gaps in the knowledge generated, especially regarding diverse cultural perspectives.
Ethical Awareness	Understanding and addressing moral issues surrounding AI.	- **Ethical prompt design**: emphasize the ethical implications of prompt engineering, such as avoiding biased language that might reinforce stereotypes or marginalize groups. ⸺ **Addressing AI bias**: use generative AI as a case study for understanding how biased inputs lead to biased outputs, discussing issues like data privacy, intellectual property, and the reproduction of harmful content. For example, the use of generative AI, like the navigation of the internet can exacerbate self-fulfilling prophesy: getting research results which confirms our ideological inclinations and biases.
Digital Literacy	The ability to critically evaluate and use digital tools and platforms.	- **Training on detecting fake media:** such as recognizing deepfakes through inconsistencies in lighting or facial movements and using verification tools to cross-check information from multiple sources. A verification tool can be looking for the sources of the produced media. - **Identifying biases in AI outputs**: teach learners to recognize when generative AI content reflects biased data, showing how to cross-verify information and refine prompts to avoid misinformation and manipulation. For instance, references mentioned by generative AI can be verified using university database and accessing scientific journals.

Second Application on AI Discourse and Power Dynamics

In this application, students will be organized into groups representing diverse stakeholder perspectives on AI use in higher education:

a) Those who are opposed to AI technologies.
b) Proponents of disseminating AI technologies in higher education.
c) Advocates for limited applications of AI in higher education.
d) Proponents of a precautionary approach until AI technology capabilities are fully understood.

The primary objective of this activity is to analyze the varied concepts and terminology used by different stakeholders, reflecting a broad spectrum of social sectors—including business, government, academia, human rights advocacy, and more—to support and frame their positions on AI use. In other words, using the field of higher education as a context, the objective is to examine different and opposing discourses on the use of AI in higher education. For example, students can be divided into multiple groups representing the sectors above to advocate for their positions on AI applications in higher education by simulating adoption of the following positions:

- Reliance on AI can lead to plagiarism and the absence of originality in submitted assignments.
- AI as a learning tool can enhance efficiency and personalized learning.
- AI can be used to encourage creativity through simulations and conversational practices.
- AI use in higher education should be halted until the technology behind it is fully understood, and students are prepared to use it responsibly.

The focus should be on examining the aforementioned stances, using role-playing to understand how proponents and opponents of AI package and present their stances and ideological perspectives regarding AI and its applications. This role-playing exercise encourages the development of discourse analysis skills (how language is being used), which are integral to critical thinking. Below are examples of some of the used concepts to advocate for the positions above:

Figure 4 Role-Playing Stances on AI

Positions on AI applications in higher education	Examples of Language used (discursive practices): concepts, terms, and theories
Reliance on AI can lead to plagiarism and the absence of originality in submitted assignments.	- Plagiarism Detection Software - Originality in Academic Writing - Ethical Use of AI in Education - Academic Integrity - Copyright Law
AI as a learning tool can enhance efficiency and personalized learning	- Adaptive Learning Systems - Machine Learning Algorithms - Personalized Learning - Efficiency in Education - Learning Analytics
AI can be used to encourage creativity through simulations and conversational practices	- Creativity Support Tools - Simulation-Based Learning - Natural Language Processing (NLP) - Creative AI - Design Thinking

AI use in higher education should be halted until the technology behind it is fully understood, and students are prepared to use it responsibility	• Precautionary Principle • Technology Assessment • Responsible AI Development • AI Governance • Ethical AI

Additionally, language analysis should be accompanied by examination of stakeholders' socio-economic status, academic and professional disciplinary backgrounds, and interests. This involves assessing their significant economic, political, and value-based motivations regarding the use of AI in Higher education. For instance, major AI companies may advocate for AI use in higher education to align with their profit objectives, educators may prioritize maintaining academic integrity, and university leadership might adopt the technology to remain competitive and abreast of technological advancements.

Debriefing suggestion: Students should be encouraged to analyze the language used by various stakeholders to support their positions on AI use in higher education. The discussion should delve into dissecting the underlying concepts and theories advanced by a certain stakeholder, while also considering their historical and cultural contexts. This is important to equip students with analytical skills to engage critically with the language used by different stakeholders, unpacking its political and value-based determinants.

For instance, when the concept of "efficiency" is used to advocate for AI use in higher education, students can critically examine this concept by highlighting its historical uses. They can also evaluate its applicability in the realm of education by asking critical questions, such as: do we need efficient learning, or do we require something deeper, such as meaningful learning? Such critical questions foster a deeper understanding of the nuances within discourse, encourage critical thinking, and promote a more nuanced analysis of stakeholders' arguments, framings of the issue at hand. Discourse analysis (how language is being used) can promote the proposed AI literacy competencies presented in figure 1, for which more examples are provided below:

Figure 5 AI Literacy Competencies and AI Discourse

AI Literacy Competencies	AI Discourse and Power Dynamics	Examples
Critical Thinking	Developing the ability to identify biases, evaluate stakeholder agendas, and assess how language affects AI outputs. Using different natural languages can lead to varying outputs. For example, generative AI models trained on limited Arabic data may exhibit deficiencies in basic development tasks.	If a generative AI model is primarily trained on English-language data, it may produce answers that reflect Western cultural norms and perspectives. For instance, when asked to generate examples of leadership qualities, the model might prioritize traits like assertiveness and competitiveness, which may not align with cultures that value collectivism or humility.
Ethical Awareness	Evaluating stakeholder's moral justification of using AI or opposing it.	This includes analyzing arguments for AI's potential to enhance efficiency and productivity versus concerns about privacy, bias, and job displacement. For example, proponents may argue that AI can streamline processes and improve decision-making, while opponents may highlight

		ethical issues related to data privacy and the risk of reinforcing systemic biases.
Digital Literacy	Learning how language choices in prompts engineering influence AI behavior and can lead to unethical and inaccurate outputs.	Biased prompts, such as the following, can lead to biased outputs: *Create an immigration policy that focuses on strict border control to prevent illegal immigration.* A more inclusive prompt would be: *Create an immigration policy that balances border security with humane treatment of migrants and pathways to citizenship.*

Third Application on Contextualizing AI Within Social Structures

This application aims to explore AI's profound impact on various aspects of our existence: life, values, economy, the future of humanity, and security. Engaging activities can be developed to analyze AI's effects on our social institutions, including religion, culture, economy, values, media, and more. These activities are designed to reflect the ongoing debate between proponents of technological determinism and social determinism. Both perspectives encompass a spectrum of beliefs, ranging from Luddites cautioning against the perils of technology to technophiles advocating for its essential role in human development and welfare. For instance, one area of examination could be the impact of AI on the economy, particularly in terms of employment, which is a key concern for college students. The economy, as a social structure, is intricately linked to technological advancements and their implications for labor markets and skills development.

According to the International Monetary Fund (Giorgieva, 2024), "AI will affect almost 40 percent of jobs around the world, replacing some and complementing others." The Pew Research Institute found that "Women, Asian, college-educated, and higher-paid workers have more exposure to AI" (Kochhar, 2023). College education, therefore, is central to discussions about AI's role in reshaping the skills necessary for entry into the labor market.

Critical literacy on AI plays a crucial role here as it enables college students to develop personal perspectives on AI's impact on their educational and career aspirations. It also empowers them to form politically informed opinions about AI policies in the job market. To do so, I propose an activity where students navigate the impact of AI on the job market pursuing four key avenues of research and thinking:

Figure 6 Learning Activity on the Impact of AI on the Job Market

Groups will be formed around the four aforementioned research and thinking avenues on AI and the job market. Each group will be composed of students from diverse disciplinary backgrounds to cultivate interdisciplinary thinking and explore the challenges associated with it in academia and the professional world. This can be a valuable exercise for students to gain appreciation for different disciplines and understand the critical importance of interdisciplinary collaboration in addressing complex problems. *Debriefing suggestion:* students should be allowed sufficient time to share their findings and the sources of their data. This fosters the development of key research skills and communication skills necessary to effectively convey research results. If needed, basic research training can be provided, prior to group activities, on obtaining reliable data by emphasizing the importance of primary data sources, peer-reviewed articles, and scholarly databases. In addition to utilizing reliable data sources, students should be supported and encouraged to demonstrate critical thinking, ethical awareness, and digital literacy when

examining the impact of AI on their employment prospects. The table below provides examples of how AI literacy can be cultivated in the context of understanding the effects of AI on employment:

Figure 7 AI Literacy Skills and Social Structures (example of employment)

AI Literacy Skills	AI within Social Structures: employment as an example	Examples
Critical Thinking	Analyzing and evaluating how AI affects job opportunities and workplace dynamics.	- Assessing the role of AI in the hiring process, such as understanding how applicant tracking systems filter resumes based on keywords. - Evaluating the potential for AI to create new job categories while also automating existing roles, leading to job displacement in certain sectors.
Ethical Awareness	Recognizing ethical implications of AI in employment practices.	- Understanding the risks of algorithmic bias in hiring algorithms, which may disadvantage certain demographic groups. - Considering the ethical responsibility of companies to ensure transparency in how AI is used for hiring and employee evaluation.
Digital Literacy	Effectively using AI tools and technologies to enhance employability.	- Learning to leverage AI-powered job search platforms that match skills to job openings, while being aware of data privacy issues. - Utilizing AI tools for professional development, such as personalized learning platforms that recommend courses based on career aspirations.

Concluding remarks and thoughts:

The sociology of knowledge and its proposed pedagogical applications can serve as engaging and meaningful learning tools to empower AI literacy among undergraduate students. The expected outcomes are threefold. First, cultivating critical thinking among college students to examine the role of AI in shaping their personal and professional lives by enabling them to detect biases in AI-generated outputs

and to question the sources of evidence and data used by generative AI tools. Second, empowering students to develop their ethical awareness by considering whether developers of generative AI systems pay attention to the ethics of technology development, such as addressing digital divides, biases, privacy, access, and affordability. Third, enhancing digital literacy by equipping students with prompt engineering skills to develop ethical prompts that allow them to responsibly benefit from generative AI technologies, as well as skills to discern and detect fake AI-generated media, such as deepfakes

The efficacy and success of the proposed AI literacy applications depend on four key criteria. First, forming groups with interdisciplinary and cultural diversity is crucial, as it allows students to educate each other on challenges based on their cultural backgrounds, fostering peer education. Second, providing engaging training to prepare students for research development enables them to use reliable and valid data sources effectively. Third, encouraging creative forms of engagement, such as skits and debates among students, facilitates the sharing of findings and reflections in a fun and engaging manner. These criteria are essential for ensuring meaningful learning and engagement while supporting students in taking ownership of the task of AI literacy as a community-based effort.

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Developing and Implementing AI Expertise in Academic Libraries: Approachability, Education, and Reading the Room

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Abstract

Academic librarians may have a responsibility to answer the call for services, resources, and education surrounding artificial intelligence in higher education. Students and instructors struggle to balance ethical dilemmas with necessary skill-building, using AI in the classroom, as new tools are rapidly evolving. Libraries could be positioned in a supportive role for campus members who are optimistic about the impacts of artificial intelligence as well as those who have serious concerns. Companies in every industry will undoubtedly be looking for AI-competent graduates as ideal candidates for hire, which means colleges and universities must update their curriculum to address these skills. This essay identifies five areas in which academic librarians can establish and implement AI expertise: collaboration, approachability, new literacy development, tangible resources, and multi-disciplinary teaching. The author provides an overview of opportunities and concerns currently dominating artificial intelligence conversations, how academic librarians are well-suited to address these topics, and why coming to a consensus on appropriate AI use is nearly impossible.

Keywords: AI literacy, artificial intelligence, outreach, professional development

Introduction

Artificial intelligence, particularly text and image generators such as ChatGPT and Dall-E, could arguably be considered the biggest disruptor to higher education since the internet itself. Students and instructors alike are struggling to keep up with these rapidly regenerating and evolving tools. Outside the classroom, industry professionals are eagerly adapting AI to streamline production and decrease staffing needs, but inside the classroom is a different story. With issues such as cheating, data security, bias, and intellectual property still largely unresolved, many academic professionals find it difficult to encourage the use of AI for education. Early adopters likened ChatGPT and similar tools to a calculator or Google Search, arguing that artificial intelligence is merely another tool designed to get users from one place to another more efficiently and successfully. Skeptics countered that even calculators and spell-check are not typically allowed in school until students have mastered the basics, which has led to an ongoing discussion about the extent to which different artificial intelligence software should be permitted at different educational levels. Despite instructors' concerns about the loss of traditional learning, however, using AI tools effectively and ethically is clearly a skill set all its own. Since higher education's goal is to prepare students for the workforce, institutions are obliged to help develop those skills.

The big question is how. How can instructors equip future professionals with the tools necessary to succeed in their respective industries without sacrificing scholarly competencies such as reading and writing comprehension, research skills, and information literacy? Enter the academic librarian. Libraries have always been an essential source for developing new literacies and teaching new

information concepts. From keyword searching to identifying credible publishers, librarians have helped students hone skills applicable to both academia and the real world. Therefore, they are perfectly positioned to contribute to artificial intelligence initiatives and conversations in higher education. This essay will establish contextual information surrounding a few major AI controversies, explain five ways in which academic librarians can help implement AI education in their institutions, and discuss why there can never be a true consensus on the value and ethical implications of artificial intelligence.

Background: "First" Impressions of Artificial Intelligence

Though generative AI emerged relatively recently, most of the technology-literate population have likely been using some form of artificial intelligence regularly for at least the last decade or two. Autofill and autocorrect, GPS, scheduling assistants, and photoshop are just a few examples of how artificial intelligence is not entirely new. What is new is its ability to accurately mimic human behavior – write essays, summarize literature, propose solutions, hold conversations – and teach itself how to improve those skills without direct human intervention. For this reason, AI has become significantly more useful in the last five years, particularly when it comes to daily administrative tasks.

Applicability in the Workplace

World Economic Forum's 2020 Future of Jobs report estimated half of employees will need to adapt their skills to new AI-driven trends, and over one-third of Deloitte's State of AI in the Enterprise 2022 report respondents indicated plans to increase AI-related investments (as cited in Ahramovich, 2023). According to Mercer's 2024 Global Talent Trends report, over fifty percent of executives predict a "10-30% productivity boost" through increased efficiency and higher-quality work as a result of artificial intelligence, intending to redesign work models around such augmentation (p. 7, 10). Business Insider has published several pieces on examples of AI use in the workplace:

- Writing and Editing Emails (Jackson, 2023)
- Fixing Code (Kim, 2023)
- Screening Job Applicants (Mattel, 2023)
- Fine-Tuning Resumes and Cover Letters (Nolan, 2022; Mok, 2023a)
- Generating Test Questions (Mok, 2023b)
- Writing Performance Reviews (Callahan, 2023)
- Drafting Marketing or Promotional Materials (Zinkula & Mok, 2024)

One article in particular argues that AI-competent job candidates are more likely to be hired because they "might be more productive, creative, and open to change than those without AI expertise" (Mok, 2023, sec. 2 para. 2). McKinsey Global Institute also released a report on AI in the workplace, predicting a significant increase in automation that will shift labor positions but not necessarily eliminate jobs outright, as long as hiring practices and professional development opportunities adapt to competency-based skill building rather than relying on traditional qualification and productivity models (Ellingrud et al., 2023).

Questions and Concerns

To effectively implement artificial intelligence across industries, companies must rethink their hiring procedures and recruitment strategies. Similarly, if colleges and universities intend to produce desirable job candidates in these new areas, instructors must rethink how they measure intelligence and what they teach in their courses. This is a huge ask, especially because AI is by no means fool-proof. As with any new technology, there is much to be debated regarding appropriate use and reasonable boundaries.

Regarding Ethics

The biggest buzzword surrounding artificial intelligence and education is cheating. When tools such as ChatGPT proved their ability to write a passable essay, many institutions scrambled to create policies prohibiting the use of artificial intelligence and invested energy into detection software which were often unreliable (Fowler, 2023; Wiggers, 2023; University of Kansas, n.d.). Many scholarly journals do not allow for AI-generated text or image in author submissions, but the American Psychological Association (APA) published guidance on citing ChatGPT last spring, which indicates there may be an argument for using artificial intelligence in professional publications as long as the extent of its contributions is made clear (McAdoo, 2023).

However, that does not solve the issue of intellectual property. The Authors Guild (2023), which has spearheaded numerous lawsuits against OpenAI for using authors' works to train ChatGPT without their consent, argues that literature composed wholly or in part by artificial intelligence "threatens to crowd the market for human authored books" (para. 3). Some early demonstrations of text- and image-based artificial intelligence in higher education included a warning that any experimentation would inevitably be used to help the software improve itself. OpenAI includes a note about this when users sign up for ChatGPT, and a Data Controls FAQ page was recently updated with directions to disable model training for future conversations (para. 2). This raises significant concerns for higher education.

Regarding Privacy

One problem with AI detection that has nothing to do with its effectiveness or accuracy is its unwitting theft of student data. Regarding intellectual property, running a student's paper through any artificial intelligence tool essentially forfeits ownership of the work. The same goes for lesson plans, draft emails, data sets in need of cleaning, code for a start-up website, and exam questions. Any sensitive or identifying information included in artificial intelligence prompts becomes vulnerable. Earlier research on the impacts of advanced technologies lumped big data and artificial intelligence together when identifying emerging knowledge and skills needed in the workforce (Johnson et al., 2021). Though data literacy and AI literacy have each evolved into their own distinct competency areas, the link between data science skills and artificial intelligence skills is still helpful for understanding the privacy and security risks inherent when using tools like ChatGPT. Raw data can easily fall victim to misuse, misrepresentation, and misinterpretation. Data scientists must understand not only how to effectively analyze data, but also how to ethically collect and communicate it. Similarly, students must learn how to generate desired content with AI

through prompt engineering, but also when and how AI tools can be used without compromising intellectual property or sacrificing sensitive information.

Regarding Critical Thinking

Beyond creative or intellectual property and personal data loss, one argument against embedding artificial intelligence in higher education is that it could become a negative substitute for critical thinking skills. First-year writing instructors at some research institutions have encouraged AI use for only certain parts of an assignment, such as brainstorming with tools like Fermat and Elicit (Watkins, n.d.). Others have proposed using artificial intelligence to assist with textual analysis, discussion questions, and background information – with the caveat that there should be some guaranteed original component such as a handwritten diagram or comparative reflection (Harvard University, n.d.). One instructor permits AI use but holds students personally responsible for any incorrect or unethical information submitted, one tries to build trust and encourage good behavior by implementing flexible deadlines, and one uses AI chatbots to help students practice empathy (McMurtrie & Supiano, 2023). While these examples represent a careful balance between traditional learning and artificial intelligence, they also compromise parts of the research and writing process that still have value, such as close reading and communication.

Critical thinking is closely related to soft skills, which are defined by Forbes Advisor as "abilities that allow individuals to effectively interact with others in a professional setting"; examples include communication, creativity, and emotional intelligence (Danao, 2023, para. 3). Using AI tools such as ChatGPT to streamline workflows, speed up idea generation, and cut down on tedious administrative tasks such as responding to emails can go a long way toward increased productivity. However, replacing creative or interpersonal tasks on too large a scale may diminish critical thought processes. If the only way to combat this is to build in a fail-safe that relies on uber-traditional learning restrictions, such as blue-book exams or compare-and-contrast reflection essays, it is worth questioning how artificial intelligence could be better represented in those areas.

Libraries and Artificial Intelligence

As leading entities in finding and using information, academic libraries are perfectly positioned to provide services and resources geared toward artificial intelligence use. Even without mentioning AI in their strategic plans, many universities offer related coursework or programming, and yet their libraries did not appear to be significant contributors in an early environmental scan (Wheatley & Hervieux, 2019). Whether librarians explicitly support or oppose the use of artificial intelligence in higher education, it is impacting their profession as much as any other. In some ways, AI has the power to replace jobs entirely, but the most immediate changes to the workforce will involve a shift in current positions. Libraries are not exempt from this. Research has identified digital search and retrieval, cataloging, processing, and circulation services as areas most likely to be significantly affected by artificial intelligence (Rifqah et al., 2022). While individual librarians may have mixed views on the positive or negative nature of these anticipated changes, their role may be to provide AI services and resources that benefit students entering the workforce regardless of their personal views.

Establishing AI Literacy: Strategies for Academic Librarians

It has been established that artificial intelligence can be a sensitive topic in higher education, and understandably so, but it is necessary to implement these technologies if students are to be adequately prepared for an increasingly automated workforce. Though libraries may not have been at the forefront of the artificial intelligence movement, they now have the opportunity to play a major role in AI literacy education. The following strategies may help academic librarians further artificial intelligence initiatives at their institutions.

Collaborate with Key Players

Academic librarians should identify and connect with other campus groups or individuals who are already implementing artificial intelligence in their respective fields. Attending professional development workshops, discussions, and presentations are great ways to become part of the AI community. Building related skills and expertise individually, in addition to communicating with other parties investing time and energy into artificial intelligence initiatives, may help librarians develop services and resources in accordance with campus community needs. Collaboration has also been known to benefit the scholarly community at large, though the question of whether research is fueling AI innovation or AI is demanding research catch up is still unclear. As Shao et al. (2020) explain, "collaboration and competition in the field of artificial intelligence progress its rapid development... [and] its rapid development calls for closer collaboration among research institutions" (p. 69735). Therefore, librarians must be mindful of how and where opportunities are coming from, but should seek to get involved, especially in cases where their existing expertise add value.

Libraries can identify potential partnerships across campus through teaching and learning centers, student success organizations, communities of practice, and student conduct offices. Subject librarians may also consider analyzing syllabi for artificial intelligence policies and assignments set by specific instructors or consulting with local businesses using AI in their workforce. For example, professors in the UK have looked at ways to apply artificial intelligence to preserve born-digital materials and expand access to digital archives, identifying trust and collaboration as key components in the process (Jaillant & Rees, 2023). By working with groups proactively using artificial intelligence tools, for a dedicated course or otherwise, librarians can offer more relevant guidance on privacy and ethics concerns. When instructors are more interested in limiting AI use, librarians can focus their efforts on balancing risks with necessary awareness, as well as provide alternative learning opportunities and materials for students. In either case, building relationships and trust with other campus groups may help academic librarians establish themselves as AI literacy experts, in addition to giving them a platform for promoting other services and resources.

Begin with the Basics

Perceptions of artificial intelligence and its applications in higher education vary wildly even within individual institutions. Therefore, academic librarians positioning themselves as AI resources should always be prepared to start with the simplest explanation for these tools. Plenty of instructors may still lack a basic understanding of what large language models are or how

machine learning works. Others may have knowledge of specific tools and applications within their field but fail to see the efficacy of AI in other industries. Offering a library introduction to artificial intelligence can be a great starting point for more in-depth conversations and allows librarians to make connections with instructors from all levels and disciplines, taking some mystery and trepidation out of AI-inclusive teaching. While it may be easy to assume students are way ahead of their professors when it comes to using artificial intelligence, their understanding may be limited as well. Hornberger et al.'s (2023) basic AI literacy test found that most students exhibited some understanding of artificial intelligence, but their study was likely limited by the fact that most of the participants were volunteers from technical programs and ChatGPT was released after the fact, meaning it is still not safe to assume prior knowledge.

A few key components of successful AI introductions are demystification, approachability, and compromise. Instructors should feel like the library is a trusted partner with a vested interest in helping their students succeed both in their classes and in their future careers. All new technology comes with skepticism, and many of the concerns surrounding artificial intelligence are valid, so it can be the academic librarian's job to make AI as transparent and empowering as possible. Librarians may point out how artificial intelligence is already being used in the workforce, give examples of AI technologies throughout history, and acknowledge primary classroom concerns along with possible solutions. This can be accomplished through open discussion, interactive games or polls, hands-on demonstrations, Q&A with active AI users, or simple lectures. The point is to find common ground with artificial intelligence tools and share knowledge beneficial to the campus community as a whole, not take sides or diminish instructors' perspectives. Librarians may correct misconceptions about AI and its applicability in higher education, positive or negative, but address concerns with compassion rather than condescension. In some cases, AI adoption will require baby steps – libraries should be mindful of this and plan education initiatives accordingly. In others, artificial intelligence may even be used to conduct its own teaching, as is demonstrated by Chen et al.'s experiment using a chatbot to teach AI basics in 2022. In the future, perhaps teaching students how to use artificial intelligence will become akin to teaching them how to find a physical book in the stacks.

Embrace Interconnectedness

Something that may help librarians exert their AI expertise and build meaningful instruction is the close relationship between AI literacy and other information concepts. Libraries are already hubs for digital, data, news, and media literacy. Though artificial intelligence made only limited appearances in related digital literacy frameworks as of 2022, according to Tiernan et al. (2023), librarians such as Gross and Rogers (2023) have presented compelling arguments for the translation of information literacy skills to AI literacy needs. Libraries provide resources on critical thinking, identifying appropriate sources, and conducting effective research every day. Artificial intelligence services and resources can fit into this fold very easily.

AI and Information Literacy

Information literacy is an important reference point when thinking about artificial intelligence because it is characterized by a series of interconnected skills. Artificial intelligence can also be a

key component of misinformation or disinformation, as an agent of misrepresentation (Tiernen et al., 2023). Information-literate students know how to find the information they are looking for, what to look for when accessing it, if it meets quality criteria, what it can be used for, and how they can communicate or redistribute it appropriately. AI-literate students will need to have a good grasp on prompt engineering, terms and conditions for software use, reliable tools, reasonable applications, and appropriate citation methods. The thought processes behind these skill sets go hand in hand. For introductory artificial intelligence sessions, librarians may consider adapting information literacy diagrams, calling back to instructors' previous assignments if applicable.

AI and Data Literacy

Researchers have previously linked artificial intelligence with data science, which gives librarians a good entry point when working with certain student and instructor populations. From a keyword mapping perspective, for example, big data and artificial intelligence are both directly tied to machine learning (Wang, 2020). Though definitions of data literacy are more varied than for information literacy, notable skills include: data visualization, data cleaning, data analysis, data preservation, data collection (Carlson et al., 2011; Wolff et al., 2016; Burress, 2022). Many text- and image-generative artificial intelligence call for a more simplified approach to these tasks. Knowing which tool to use and what kinds of descriptors to prioritize to generate acceptable results, for example, may be an extension of the decision-making required when choosing a graph to visualize data. Access models, stored chats, and ownership policies are similar factors to what must be considered when making a data preservation plan. Everyone can benefit from some sense of familiarity when learning a new concept, and librarians can capitalize on that when introducing AI literacy.

Provide Tangible Resources

Though face-to-face instruction and live sessions may be preferable for discussing new initiatives in higher education, building awareness and support for something as impactful as artificial intelligence may also include ready-reference materials that can be revisited by individuals at any time. Singh and Riedel (2016) emphasize the importance of textual descriptions and visual materials in particular, adding that students should be able to interact with AI materials in as seamlessly an environment as possible. Both digital and physical objects can serve as touch points for students or instructors struggling to use artificial intelligence effectively. Librarians have previously demonstrated instruction approaches combining face-to-face teaching with electronic supplements (Gross, 2023). No format will be perfect for all campus populations; libraries may try to develop different options for different audiences.

For Instructors

Brief tutorial videos – how to install and set up AI software, sample AI-generated lectures, interviews with AI professionals – may be good for instructors who can dedicate time to professional development. IBM, Google Cloud, DeepLearning.AI, Microsoft, and some individual universities provide educator-specific training modules on artificial intelligence (Coursera, 2024). Videos are beneficial because they can be kept on a shared drive, viewed asynchronously or as

needed, and paused to follow step-by-step instructions. Training materials such as these should be made available before the start of the semester, though, especially if they cover AI implementation in assignments or course sites. Instructors may also benefit from sample assignments using artificial intelligence tools. Examples may include things like think-pair-ChatGPT-pair-share (Finley-Croswhite, 2023; Montana State University) and AI image remixing or comparing (Wller, 2023; Yousufi, 2024). The goal of AI literacy implementation is not to create more work for instructors, so professional education materials should be as straightforward and practically applicable as possible.

For Students

Like instructors, students come from a range of backgrounds, and thus have varying experience levels with artificial intelligence. Libraries can provide materials catered to beginner, intermediate, and advanced understandings of AI. Druga et al. (2022) recommend developing artificial intelligence resources with cognizance of different students' prior knowledge levels and access to technology, including directions for use and societal contexts, and building in opportunities for feedback. Librarians can also consider tailoring educational materials to their individual liaison areas, particularly for creative disciplines, and partnering with other campus entities to host AI-related events. Take-home materials such as handouts, flyers, and best practice lists also have numerous benefits. Libraries may put up flyers featuring AI tools to promote a study session, upload a list of prompt editing tips to their website, or provide business cards for campus experts at the circulation and reference desks.

Adapt Instruction Across Disciplines

The most important thing to remember about AI instruction, particularly for academic librarians, is that no two disciplines have the same point of view. Different industries encourage, tolerate, or prohibit AI use for different reasons. Librarians should neither invalidate instructor concerns nor bolster instructor overconfidence. This is what separates AI literacy from other competencies such as information literacy – which has more widely accepted rules (American Library Association, 2015) – one community's cheating may be another's efficiency.

AI in Humanities – Creating is the Point

Reading- and writing-based disciplines are more likely to emphasize the finishing and polishing capabilities of artificial intelligence. For British literature students writing a paper on major themes in Jane Austen's works, for example, it is more appropriate to use ChatGPT to generate an outline based on their original ideas than to have it write a list of themes upfront. These students may also benefit from AI "when they search archives or take 'big data'-focused digital humanities courses" (Hutson et al., 2022, p. 3966). Art or creative writing instructors may prohibit AI in the first-draft or sketching stage but encourage students to use Fotor to replicate and compare subjects. Hutson et al. (2022) also note that designers now have an enhanced ability to search for stock images, edit photo or video materials, or experiment with the same subject in different styles. History, linguistics, gender studies, or psychology students may be asked to test the originality of their theses by using Elicit to search for or analyze existing research. Librarians should always be mindful of the instructor's priorities and intent of the assignment when working with these groups.

In discussion-based disciplines, using artificial intelligence even for something as introductory as brainstorming or posing counterarguments might defeat the purpose of the course, if learning how to think is the main objective. Libraries can support these types of programs by teaching AI as an editing, promotional, or fine-tuning tool for existing ideas or research. AI literacy education in these areas may spend extensive time on ethics, creative or intellectual property, and copyright discussions.

AI in STEM – Priorities in Problem-Solving

STEM students may find value in AI-generated text, particularly for writing reports or summarizing findings for general audiences, as well as more technical AI capabilities such as fixing code. The interactive piece of artificial intelligence is particularly important in these disciplines, according to Hutson et al. (2022), because it can supplement traditional learning and provide additional feedback dependent on individual student interactions. Because these students complete practice-based projects, instructors may more frequently pull artificial intelligence tools and guidance from industry leaders. A first-year writing instructor may be horrified by students using Quillbot to generate comments for class discussion, but an upper-level science instructor may argue their ability to run an experiment correctly is more important than describing it. Students may spend months developing code, only to realize it has one minor flaw – AI can identify that fault without the group having to start over (CodeInterview, 2024). STEM students may value results and functionality over process and explanation. Librarians teaching AI literacy in these areas can embrace technical assistance tools, which typically require more user experience and knowledge. Students may also need an in-depth explanation of how their input can become public when running works through artificial intelligence.

AI in Human Services and Consumer Sciences – Efficiency Above All

Consumer sciences and applied human services such as education, health care, and social work interact closely with the general public. Therefore, these students need artificial intelligence that can increase productivity without sacrificing quality of care and simulate real-world environments, as well as provide useful feedback (Hutson et al., 2022). Much of the automation happening in these fields relates to administrative work – supply-chain management, inventory processing, web portal improvement, customer service chat bots (Burton, 2024) – so students may be asked to use their education in new ways upon entering the workforce. Design students may use Interior AI to visualize ideas for a project proposal, social work students may use Lingostar to practice conflict resolution through therapy role-play, and nursing students may use Limbiks to generate flash cards while studying for final exams. Because applied and consumer sciences include many different types of majors, librarians may need to be well-versed in a variety of AI tools and willing to expand their expertise on an as-needed basis. Many of these disciplines also have a business component, which means artificial intelligence can play a role in client relations and consumer education materials, so libraries serving these populations should remain vigilant in AI privacy and security instruction as well.

Discussion: Challenges in Inconclusiveness

Not every librarian will have reason to develop extensive AI expertise over the course of their career, even in academia. However, artificial intelligence is at work in information sciences as much as any other industry, so there is a responsibility to at least be aware of its capabilities. This is difficult, because new technologies have proven to be rapidly evolving and expanding, so keeping up with AI will likely prove to be an impossible task. Free tools assigned by instructors for certain classes may disappear from one semester to the next, replaced by a different model or regenerated behind a paywall. New detection methods may emerge, then be labeled inadequate. Students may come to higher education with the idea that generative artificial intelligence is today's technological miracle or the next great evil. Academic librarians may need to be prepared to address problems and concerns as well as provide services and resources guiding proper use. This task is not wholly new to libraries; emerging literacies have been a staple of the profession for years.

What is unique about artificial intelligence in higher education, from an academic library perspective, is the inability to decisively argue for or against it. Some industries are using AI extensively, and therefore expect graduates to come in with those skills. Others are warring with AI software companies for rights to creative and intellectual property, encouraging users to reject artificially generated content. Both types of students are present in colleges and universities. Both communities can benefit from AI literacy. Librarians' personal views may be influenced by their educational backgrounds or work experiences, but their instructional support can be informed by disciplinary contexts and adapt to evolving trends.

Conclusion

Academic librarians can support artificial intelligence initiatives through collaboration, education, concept mapping, supplementary materials, and adaptation. Connecting with other campus partners to expand services and resources will ensure the library is at the forefront of innovation. Making AI concepts user-friendly for students and instructors at all levels will create a culture of shared learning that does not alienate less experienced users. Information and data literacy concepts offer a familiar foundation from which to teach AI literacy. Providing easy-to-use resources that can be accessed independently will enable continued learning and improvement as new technologies continue to evolve. Finally, tailoring content to disciplinary needs and being open-minded about different attitudes regarding AI use will allow libraries to effectively serve the maximum amount of current and future professionals. Ethical considerations, career opportunities, and critical thinking should be at the forefront of all AI literacy services and resources. Artificial intelligence is an awe-inspiring tool with infinite possibilities, but it can fall victim to misuse like any other resource.

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Enhancing or Undermining? Evaluating the Impact of AI Writing Tools on Student Skills Development in Rural High Schools

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Abstract

This study evaluates the impact of AI writing tools on writing skills development among high school students in a rural setting. By examining improvements in grammar, structure, and argumentation over a four-week intervention in a freshman English class, the research aims to identify both the enhancements and limitations of these tools. Findings from the teacher observations, group surveys, and teacher reflections indicate that while AI tools streamline writing tasks and reduce anxiety, they do not significantly advance deeper writing skills, raising concerns about fostering an overreliance on technology. Challenges include technological barriers, ethical issues, and a lack of tool familiarity. The study advocates for a balanced approach to integrating AI in educational practices, emphasizing the need for strategic curriculum development, comprehensive teacher training, and clear usage guidelines. This research contributes to the discourse on leveraging technology to enhance educational outcomes in rural areas effectively and ethically.

Keywords: AI writing tools, rural education, digital literacy, AI in education

Introduction

The integration of Artificial Intelligence (AI) into educational settings has the potential to address disparities in academic achievement, particularly among marginalized populations. By leveraging AI, educators can provide personalized learning experiences tailored to the unique needs of each student, which can be especially beneficial in underserved areas where resources are limited. AI tools can also assist in identifying learning gaps and provide targeted interventions to help students who may be falling behind. Furthermore, the use of AI in education can facilitate access to high-quality educational content and support, bridging the gap between different socioeconomic groups. This research project is designed to investigate the

effectiveness of AI tools in enhancing writing skills among high school students in a remote, rural area of Nebraska, USA. While AI holds significant promise for educational innovation, there remains a paucity of focused research on how these technologies can be leveraged to foster educational equity through practical classroom applications. Our study aims to address this gap by deploying AI-driven tools such as Grammarly, ChatGPT, ProWritingAid, and Hemingway within the English Language Arts curriculum to improve student writing. Specifically, the project examines the impact of AI on key aspects of writing, including grammar accuracy, structural organization, thesis statement development, and the use of evidence in argumentation.

The effectiveness of these AI tools will be evaluated through a combination of teacher observations, student surveys, and teacher's reflection, aiming to generate empirical data on their impact. By documenting these outcomes, the study seeks to provide valuable insights into the practical integration of AI in educational practices, with a particular focus on enhancing learning outcomes for students with socio-economic disparities. Ultimately, this research contributes to the broader dialogue on educational equity, proposing evidence-based strategies that utilize advanced technologies to address the diverse needs of contemporary students. This attempt not only enriches our understanding of AI's role in education but also offers a model for other regions facing similar challenges in educational disparity.

Introduction to AI in Educational Settings

The use of AI in educational contexts has progressively expanded. These AI applications are particularly valued for their ability to personalize learning experiences and provide targeted, individualized support to students, which has been shown to enhance student engagement and academic performance across a range of disciplines (Lo, 2023; Mishra et al., 2023). For instance, AI-driven platforms can adapt to the learning pace and style of each student, thereby offering a more tailored educational experience that is often lacking in traditional classroom settings (Thimmanna et al., 2024).

Despite the noted advancements in AI tools for educational purposes, empirical research focusing on their specific impact in rural high school settings is still relatively limited. While the initial findings, such as those from pilot studies by Crompton et al. (2024), indicate that AI tools can significantly enhance student learning skills, their effectiveness appears to be influenced by a myriad of contextual factors. Key among these factors is the availability of robust technology infrastructure, which is often lacking in rural areas. Without reliable internet access and modern computing facilities, the implementation and functionality of AI tools can be severely compromised, thereby affecting their potential benefits in these environments (Crompton et al., 2024; Aytac, 2024). Furthermore, the effectiveness of AI tools is heavily dependent on the level of teacher training and readiness. Teachers must not only be equipped with the necessary technological skills but also need pedagogical knowledge on how to integrate these tools effectively into their teaching practices. Studies (Lancaster, 2023; Lo, 2023, Mishra et al., 2023) have shown that when teachers are properly trained to use AI tools, the impact on student outcomes is markedly positive. Conversely, a lack of adequate training can result in underutilization of these technologies, failing to harness their full potential. The integration of AI tools into the curriculum also plays a critical role in their effectiveness. Effective integration

involves aligning AI tools with the curriculum goals and teaching methods that complement traditional educational approaches. This ensures that AI tools serve as a support mechanism rather than a replacement, enhancing the learning experience rather than overshadowing traditional pedagogical methods. Research by Wu and Yu (2024) highlights that AI tools are most effective when they are used to augment existing teaching strategies, providing additional support and enrichment rather than acting as standalone solutions Moreover, the sociocultural context of rural schools can also influence the effectiveness of AI tools. Factors such as community perceptions of technology, the value placed on education, and the general level of engagement with digital tools can either facilitate or hinder the acceptance and utilization of AI in educational settings. Studies by Southworth et al. (2023) suggest that in communities where technology is viewed positively and its educational benefits are well understood, the integration of AI tools is generally more successful.

In sum, while the potential of AI in education is widely acknowledged, its role in addressing the specific challenges of rural education, especially in enhancing writing skills, calls for a more focused and contextualized research agenda. This would not only contribute to a more equitable educational landscape but also ensure that the benefits of AI in education are accessible across diverse geographical and socio-economic settings.

Effectiveness of AI Tools in Enhancing Writing Skills

The effectiveness of AI tools in enhancing writing skills has been substantiated by numerous studies, underscoring the transformative impact these technologies can have on educational outcomes. Tools such as Grammarly and other recent AI-driven platforms are particularly noted for their ability to refine grammar, punctuation, and style, significantly enhancing the overall quality of student writing. Research conducted by Bennett et al. (2022) has demonstrated that the real-time feedback provided by these platforms helps students identify and correct errors instantly, which fosters a more active learning process and leads to better retention of writing rules. Moreover, AI platforms extend beyond basic grammar and style corrections. Recent tools like ChatGPT have been effectively utilized to improve higher-order thinking skills, such as argumentation and critical analysis. Tabib et al. (2024) highlights how interactive writing sessions with ChatGPT stimulate students to formulate and refine their arguments, enhancing their critical thinking abilities in the process. This interactive approach not only improves written expression but also encourages deeper engagement with the content. In addition to these capabilities, AI tools are also instrumental in personalizing learning experiences in writing. ProWritingAid, for instance, offers detailed reports on writing style, word choice, and readability, which allows students to understand their unique writing habits and areas for improvement (Zebua & Katemba, 2024). Such personalized feedback is crucial in helping students develop a distinct and effective writing voice, which is often challenging to achieve through traditional teaching methods alone.

The use of AI in writing also extends to its inclusivity and adaptability, making it suitable for diverse learning environments and educational needs. Many studies (Wu, 2024; Tabib & Alrabeei, 2024) have shown that non-native English speakers benefit greatly from consistent interaction with AI writing aids, which support their language acquisition and integration into

mainstream education systems. These tools provide a supportive, on-demand resource that can be particularly empowering for ESL students, who may require more time and specialized support to master academic writing standards. Furthermore, AI-driven writing tools are not just enhancing individual skills but also revolutionizing how writing is taught and assessed in classrooms. According to Javaid et al. (2023), the integration of AI tools in educational settings promotes a more dynamic and responsive teaching environment. Teachers can leverage AI analytics to better understand class performance trends and individual student progress, enabling more informed instructional decisions that target specific student needs.

In conclusion, while the potential of AI tools to enhance writing skills in rural high school settings is significant, their effectiveness is contingent upon a complex interplay of technological, pedagogical, and sociocultural factors. This study aims to address these challenges by deploying AI-driven tools such as Grammarly, ChatGPT, ProWritingAid, and Hemingway within the English Language Arts curriculum. By focusing on improving key aspects of writing, including grammar accuracy, structural organization, thesis statement development, and the use of evidence in argumentation, the project seeks to provide a comprehensive understanding of how these tools can be effectively integrated into rural educational settings. The goal is to enhance students' writing skills and academic performance, offering evidence-based practices that leverage technology to meet the diverse needs of students in rural high schools.

Classroom Context

The teacher conducted this research project under the supervision of a college faculty member who served as her research mentor in a graduate- level class. She also agreed to allow the mentor to use the data for academic publication. She taught a freshman class of 20 students at a small rural high school in western Nebraska. Of these students, 44% qualify for either free or reduced-price lunch. The class is predominantly White, making up 82.4% of the population, while 17.6% are Hispanic/Latino students whose native language is Spanish. The gender distribution is nearly balanced, with 51% male and 49% female. Due to the small class size, further demographic details were not included. According to the teacher, these students typically excelled in small group interactions but often struggled to maintain focus on individual tasks. They faced difficulties with essential writing skills such as grammar, word choice, organization, thesis development, and the proper use and citation of textual evidence. Additionally, they often lacked a clear understanding of their audience and the purpose of their assignments. Due to the school's small size, the students were deeply involved in a variety of extracurricular activities, including Future Farmers of America (FFA), band, speech, quiz bowl, One Act, and various sports. This extensive involvement frequently led them to postpone their academic responsibilities. In addition, the limited time they devoted to homework sometimes resulted in tendencies towards plagiarism. Before starting this project, she had introduced an informative writing assignment, giving students a full class period to brainstorm topics with the aid of a writing sample she had prepared and a list of school- appropriate topics. Despite this support, the teacher observed that many students still felt overwhelmed and sat before blank screens, unsure of where to start. While some began exploring topics that interested them, others were paralyzed by the task at hand. The observed difficulty in starting to write, even with the provided writing sample and list of topics, affected nearly all students in the class, including White students. This widespread

issue suggests that the problem is not solely related to the cultural or educational backgrounds of English Language Learners (ELL). Instead, it indicates that the challenge may stem from other factors affecting all students, such as writing anxiety, lack of confidence, or unfamiliarity with the writing task. This experience led her to question whether it was a missed opportunity not to incorporate AI tools like ChatGPT for brainstorming. After exploring ideas with the research mentor, the teacher decided to integrate AI tools to help improve the educational experience for her students.

To maximize the benefits of AI tools in enhancing student writing, she taught her students how to use these tools appropriately. This included providing technical guidance on how to navigate AI interfaces and ethical guidance to ensure they were used to enhance learning while maintaining academic integrity. By thoughtfully integrating four specific AI tools: Grammarly, ChatGPT, ProWritingAid, and Hemingway into the classroom, she aimed to provide the necessary support to help students overcome initial hurdles in writing assignments, fostering a more productive and engaging learning environment. Each week, she and her students explored the concept of AI, engaging with TED Talks about AI technology to lay a foundational understanding. Following these discussions, they experimented with those four different AI tools during typical in-class writing assignments. In her class, most writing assignments required students to compose complete sentences and cite textual evidence from assigned readings in their English Language Arts curriculum. Tools like Grammarly and ChatGPT were utilized to enhance the overall quality of student writing, while ProWritingAid and Hemingway were especially helpful for students struggling with conciseness and style.

Data Collection

The teacher collected two different data sources for this project from a freshman class at a small rural high school in western Nebraska. Her first data source consisted of educator observation forms, which she completed during the AI implementation period (appendix 1). This observation checklist helped her focus on important questions relating to the implementation process. Instead of filling out an observation form for each student, she placed 20 freshmen in five groups of four and wrote observations for each group. Another form of data collection was from group surveys (appendix 2). Groups received paper copies of the surveys after applying the AI tool while writing. She collected the surveys from groups and analyzed the feedback. These surveys helped her collect student opinions regarding AI and its benefit to student writing beyond her limited observations.

She began the AI implementation in four weeks and collected four total weeks of data. During the first week, she introduced the AI writing tool Grammarly, with which students quickly became proficient. The following week, she introduced ChatGPT. In the third week, students used ProWritingAid, and finally, they experimented with a tool called Hemingway. Responses to the Group Surveys indicated that students who were least familiar with Grammarly were English Language Learners (ELL) while the rest of the students reported that they had used Grammarly before. Three groups claimed to have used AI writing aids "frequently". One group marked "rarely or never" and another marked "sometimes." The four groups that were familiar

with Grammarly marked that they "strongly agreed" that AI writing tools have helped them develop their writing skills while the group with less experience with the tool marked "neutral." Next, she had students discuss and use ChatGPT. All five groups, including her ELL group, were familiar with ChatGPT and marked "frequently" for using ChatGPT as well. According to the teacher, the results of question 4 "Do you believe that AI writing tools have helped you develop your own writing skills? " surprised her somewhat. When asked to examine the selected AI writing tool's effect on student writing, three groups selected "neutral" regarding AI improving their writing skills. One group marked "disagree" and another marked "strongly disagree." Many groups wrote under their circled response that they did enjoy using ChatGPT, and it does "help their writing sound better." However, they did not think their writing skills developed by using the tool. Some students expressed how it is easier to use ChatGPT to improve their grades for writing assignments. The next AI tool introduced was ProWritingAid. This implementation was the least successful because it was difficult to get the free trial period working on students' Chromebooks. Furthermore, this app was less familiar to students compared to tools like Grammarly and ChatGPT. Only one group selected that they had used the ProWritingAid tool, while the four other groups marked "no". Similarly, the frequency of use of the tool for all five groups was "rarely or never". After eventually getting the tool to work and using it, one group marked that they "agreed" that ProWritingAid could enhance their writing skills. This group particularly liked the fact they can select the type of writer they are, including academic, fiction, non-fiction, business, technical, creative, and so on! Four other groups marked "neutral" for question 4 "Do you believe that AI writing tools have helped you develop your own writing skills? ". The last writing tool intervention she introduced was Hemingway Editor, notably named after American author Ernest Hemingway due to his concise, ambiguous writing style. Only one group had used Hemingway before, while four other groups selected "no". All five groups selected "rarely or never" on the frequency of using Hemingway for assignments. After the implementation of Hemingway in class, three groups selected "agree" to the question about the tool improving student writing while two other groups selected "neutral." The tool can reduce the number of words and sentences used.

In the observed integration of AI tools into her class, the teacher noted varying levels of student engagement and interaction across different AI platforms such as Grammarly, ChatGPT, ProWritingAid, and Hemingway. Initially, Grammarly was met with positive engagement as students explored its capabilities beyond basic grammar checks, delving into features that refined the intent and formality of their writing. This engagement was characterized by emotions ranging from neutral to surprise, especially as students discovered Grammarly's "intent" feature, which many had not used before. One student remarked, "*I've used Grammarly to fix my writing but don't think much about the intent,*" highlighting a newfound awareness of the tool's potential. However, the introduction of ChatGPT and Hemingway brought forth different challenges and observations. ChatGPT, used in a more in-depth writing assignment on John Steinbeck's Of Mice and Men, was initially discussed in the context of its controversial aspects in education. The teacher noted, "*Before giving a demonstration of the AI writing generator, students and I discussed why ChatGPT is currently so controversial*". Post-discussion, students used ChatGPT to refine their drafts, requesting the AI to make their paragraphs sound better or make their paragraphs shorter. Despite its benefits in enhancing the text, the tool's complex vocabulary sometimes hindered comprehension, especially for ELL students, leading to a crucial realization

about the appropriateness of AI tools for diverse student needs. ProWritingAid presented technical challenges, particularly with software compatibility on Chromebooks, which affected its usability and led to decreased student engagement. Despite these challenges, the tool offered comprehensive writing features, though they were sometimes overwhelming for both students and the teacher. The Hemingway tool was introduced last, focusing on improving conciseness in writing. The teacher observed, "*Some of my students struggle with conciseness in their writing... I wanted to see if Hemingway could reduce the 'wordiness' of some responses*". This tool was generally well-received, with three out of five groups finding it useful for improving writing clarity and conciseness. Hemingway's ability to provide a readability score was also noted as a potentially valuable feature for assessing and guiding student writing levels at the start of the academic year. During the implementation phase, the teacher observed that three out of five student groups found Hemingway useful in reducing wordiness and improving the clarity of their writing. The tool's readability score feature was particularly beneficial for students to assess and adjust the complexity of their sentences. For instance, one group noted that Hemingway helped them cut down unnecessary words and achieve a more direct and impactful writing style. This observation was supported by the teacher's reflective journal, which highlighted that students, who previously struggled with conciseness showed significant improvement in crafting clearer and more concise responses after using Hemingway. The positive reception and noticeable enhancement in writing quality among these groups underscore Hemingway's effectiveness in addressing the specific challenge of wordiness in student writing.

In addition to those two data sources, the teacher kept a reflective journal entry highlighting her experiences integrating AI writing tools once a week for four weeks. The teacher also agreed to share her reflective journal as a third data source with the researcher. By using multiple data sources including classroom observations, students' surveys, and teacher's reflective journal, we can cross-check information and confirm consistent patterns. This approach reduces biases and enhances the credibility of results, providing a more comprehensive understanding of educational practices and student experiences. As noted in her journal, the integration of AI writing tools into her classroom activities provided both the students and the teacher with a deeper understanding of AI technology. She anticipated that the study would reduce student anxiety, boost confidence levels in writing, and enhance the quality of student work. While the quality of work was challenging to quantify, she observed a notable increase in students' confidence and positive emotions as they persevered through writing assignments as she noted, "*I did observe positive emotions, specifically increased levels of confidence as students persevered during writing assignments.*" Despite the overall success, several challenges emerged, including occasional lack of interest, unfamiliarity with certain tools, and issues related to cost and compatibility. The teacher reflected, "*Challenges emerged during this process, which include a lack of interest at times, a lack of familiarity with certain tools, and cost/compatibility issues.*" She also remarked that AI tools could effectively teach "big picture" English writing concepts such as writer's purpose, style, tone, and plagiarism detection. She stated, "*Specific features within AI writing tools can be helpful for teaching students 'big picture' English writing concepts such as writer's purpose, style and tone, and even citations by highlighting plagiarism.*" According to her, these tools provided valuable support in illustrating complex writing principles and enhancing students' understanding. The teacher emphasized the importance of maintaining the goal of education—to develop critical thinkers. She remarked, "*The main lingering question is how do*

teachers balance allowing students to use AI without fostering a reliance on technology?" Over-reliance on AI raises ethical questions related to cheating and plagiarism. The teacher highlighted the necessity for clear guidelines and designated AI usage time to mitigate these risks, noting, "*Teachers can learn more about AI and set aside specific AI usage time and communicate specific guidelines for how students are to use AI.*" Also reflecting on the experience, the teacher stressed the importance of professional development focused on emerging AI technologies. She pointed out, "*The importance of more professional development centered on emerging AI technologies is crucial.*" By learning more about AI and experimenting with its applications, educators can better integrate these tools to benefit their students. According to her, AI should not replace educators but serve as a complementary tool to enrich the learning process.

In summary, the integration of AI writing tools in a freshman English class at a rural high school provided insightful results. Data collected from the teacher observations and group surveys revealed that while ELL students were less familiar with Grammarly, most other students had prior experience with it and used it frequently. Grammarly was found to boost confidence and enhance writing skills. ChatGPT, although familiar and frequently used, had mixed reviews regarding its impact on writing development, with some students appreciating its ability to improve writing quality but not necessarily their writing skills. ProWritingAid faced technical challenges and lower familiarity, resulting in minimal engagement and mixed feedback on its effectiveness. Hemingway was well-received for improving writing conciseness and clarity. The teacher observed increased her student confidence and positive emotions but also noted challenges such as occasional lack of interest, technical issues, and the need for clear guidelines to prevent overreliance on AI. She emphasized the importance of professional development to effectively integrate AI tools, suggesting that AI should complement rather than replace traditional teaching methods.

Discussion

The integration of AI writing tools within a rural high school English classroom has highlighted several pedagogical insights and practical challenges. The teacher's observation form, group surveys and journal reflective questions have provided a multifaceted view of how such tools—Grammarly, ChatGPT, ProWritingAid, and Hemingway—impact student learning. Initially, Grammarly was met with positive engagement, improving students' confidence and proficiency in writing. However, as subsequent tools were introduced, varying levels of familiarity and technical challenges influenced their effectiveness. For instance, ProWritingAid was less successful due to compatibility issues with Chromebooks, underscoring the critical role of infrastructure in the effective deployment of technology in education. Survey responses indicated that while students appreciated the AI tools for improving the presentation of their writing, they were uncertain about the tools' impact on genuine skill development. This observation is pivotal as it highlights a potential disconnect between using technology as a support mechanism and its effectiveness in enhancing fundamental writing abilities. Students valued the convenience and immediate feedback from AI tools like Grammarly and ChatGPT. However, some voiced concerns that these tools might not foster a deeper comprehension or advancement of writing skills, potentially serving more as shortcuts to complete assignments rather than educational aids. This concern reflects the findings of Johnson and Smith (2022), who noted a similar lack of

substantial skill development and critical engagement with writing among students relying on AI tools.

The discussion about ChatGPT was particularly revealing, showing both the opportunities and the controversies surrounding AI in education. While it helped students enhance their drafts and made writing assignments less daunting, there was an ongoing debate about its appropriateness, especially for ELL students who might struggle with the advanced language output from the tool (Lee & Nguyen, 2021).

From a pedagogical perspective, these tools have been instrumental in teaching complex writing aspects such as style, tone, and plagiarism. However, the teacher's reflection highlights a significant concern: the risk of developing an overreliance on these technologies. The ethical implications, such as potential increases in plagiarism and reduced student engagement with the learning process, were noted as areas needing vigilant monitoring and guidance (Cardona, Rodríguez & Ishmael, 2023).

Looking forward, the study underscores the importance of a balanced approach to integrating AI in educational settings. It suggests that while AI can be a powerful tool for enhancing educational outcomes, its role should be carefully managed to complement traditional teaching methods rather than replace them. This involves not only providing the necessary technical infrastructure but also ensuring that both teachers and students are adequately prepared to use these technologies effectively. The teacher's reflection advocates for more professional development focused on AI, to equip educators with the knowledge and skills needed to integrate these tools responsibly and effectively (Thompson & Lee, 2025).

In conclusion, while AI tools offer promising benefits in educational contexts, particularly for enhancing writing skills and reducing student anxiety, they also pose challenges that require thoughtful integration into the curriculum. The findings from this study contribute to the broader dialogue on educational equity and technology integration, emphasizing the need for ongoing research, professional development, and ethical consideration in the use of AI in education.

Implications of the Study

The findings of this study have several important implications for the integration of AI writing tools in educational settings, particularly in rural high schools. First, the use of AI tools like Grammarly, ChatGPT, ProWritingAid, and Hemingway offers a valuable opportunity to enhance the presentation aspects of student writing, which could lead to increased confidence and engagement with writing tasks. However, the study also raises critical concerns about the depth of learning and development of intrinsic writing skills when relying heavily on AI tools.

1. Curriculum Development: Educators should consider how AI tools are integrated into the curriculum. While these tools can enhance the writing process by correcting grammar and suggesting improvements, there is a need to ensure they are used to complement traditional teaching methods that emphasize critical thinking and writing skill development. Educators might incorporate AI tools as part of a broader strategy that includes explicit instruction on writing mechanics, style, and structure, thus maintaining a balance between automated assistance and rigorous educational standards.

2. Teacher Training: The effectiveness of AI tools heavily depends on the level of teacher preparedness to integrate these technologies into their teaching practices effectively. Professional development programs should be designed to equip teachers with the necessary skills to use AI tools judiciously, emphasizing the pedagogical strategies that leverage AI for teaching complex writing concepts without fostering overreliance. Professional development is crucial for the effective integration of AI tools in education because it equips teachers with the necessary skills and knowledge to utilize these technologies to their fullest potential. Without proper training, teachers may struggle to incorporate AI tools effectively into their lesson plans, potentially leading to underutilization or misuse. As noted in the study, AI tools like Grammarly, ChatGPT, ProWritingAid, and Hemingway can enhance various aspects of student writing, but their impact is significantly amplified when teachers are well-versed in both the technical and pedagogical aspects of these tools. Professional development programs help teachers understand how to balance the use of AI with traditional teaching methods, ensuring that AI tools complement rather than replace the essential elements of critical thinking and personalized instruction. Moreover, ongoing professional development allows teachers to stay updated on the latest advancements and best practices in AI technology, fostering an educational environment that is both innovative and effective.

3. Ethical Considerations and Digital Literacy: This study highlights the ethical considerations necessary when integrating AI into writing instruction, particularly the risks associated with plagiarism and the potential for students to become overly dependent on technology. Educational stakeholders should create clear guidelines and instructional strategies that teach students not only how to use AI tools effectively but also how to critically evaluate the assistance these tools provide. Additionally, fostering digital literacy becomes crucial, ensuring students understand both the capabilities and limitations of AI in academic settings.

4. Policy and Infrastructure: For rural schools, where technological disparities can limit the effective use of AI tools, policymakers need to consider infrastructural investments that ensure equitable access to advanced technologies. Enhancing internet connectivity and providing modern computing facilities would support the successful implementation of AI tools and reduce the digital divide.

5. Further Research: The findings suggest a need for ongoing research to explore the longitudinal effects of AI tools on student writing and learning outcomes across diverse educational settings. Future studies could focus on specific aspects of AI integration, such as the impact on English Language Learners (ELLs) or the differential effects based on students' initial writing proficiency levels.

By addressing these implications, educators and policymakers can better harness the potential of AI tools to enhance educational outcomes while lowering the risks associated with their use. This balanced approach will be crucial in preparing students not only to succeed academically but also to thrive in a technologically advanced society.

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Appendix 1: Educator Observation Form

Observer's Name:

Date of Observation:
Group Observed:

AI Integration with Writing
1. Describe which AI tool is being covered and then implemented into the writing assignment.

2. Describe if groups were actively engaged or not when using the AI tool.

Student Integration with AI
3. How are students interacting with AI during the lesson? (Emotions observed could include: excited, frustrated, indifferent, etc.)

4. Were students able to use the AI tool effectively or was it difficult to use for whatever reason (software compatibility with Chromebooks, cost, etc.)?

5. Describe any positive or negative observations in student interaction with AI.

Overall Observations
6. What are areas of improvement were identified in integrating AI tools in the classroom?

Another form of data collection was from group surveys (appendix 2). Groups received paper copies of the surveys after applying the AI tool while writing. I collected the surveys from groups and read the feedback. These surveys helped me gauge student opinions regarding AI and its benefit to student writing beyond my limited observations.

Appendix 2: Group Surveys

Group:
Date:

Directions: Circle the answer that fits with the majority of the group.
1. Have you used this particular type of AI writing tool before?
   Yes
   No

2. How often do you use this AI writing tool? (This could be in English or another class).
   Rarely or never
   Sometimes
   Frequently

3. How easy do you find it to use AI writing tools?
   Very easy
   Somewhat easy
   Neutral
   Somewhat difficult
   Very difficult

4. Do you believe that AI writing tools have helped you develop your own writing skills?
   Strongly agree
   Agree
   Neutral
   Disagree
   Strongly disagree

5. What are the types of AI writing tools that you prefer?
   Grammar checkers
   Writing assistants/ suggestions
   Brainstorming tools
   Other: _____ (specify)

Finally, I obtained data via reflective journal questions (appendix 3), which were completed after students experimented with the weekly AI tool. The purpose of the journal is for myself and other educators, who may replicate this study, to consider the effectiveness of the intervention, what was learned, and how the results may impact their future instructional practices. The reflective journal highlighted observed successes, challenges, and new learning opportunities.

Appendix 3: Reflective Journal Questions

1. What were your initial expectations and goals for integrating AI writing tools in the ELA classroom?

2. How did you envision the tools improving student writing?

3. Overall, how did students respond to the use of AI writing tools?

4. How will this intervention process impact your teaching practices?

5. How will this process possibly influence how you teach writing in the future?

6. Did you observe any improvement in student writing and/or confidence with writing?

7. What challenges did you encounter while implementing AI writing tools?

8. Reflect on any areas of professional development needed to effectively utilize AI in the ELA classroom.

9. What key takeaways do you have from this experience?