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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