

Suggestions for Incorporating Artificial Intelligence in Ph.D. Student Training in the Field of Accounting

Alisa Brink
Virginia Commonwealth University
agbrink@vcu.edu

Benjamin Chapin
Virginia Commonwealth University
chapinbe@vcu.edu

Bernhard Reichert
Virginia Commonwealth University
bereichert@vcu.edu

Mi (Jamie) Zhou
Virginia Commonwealth University
mizhou@vcu.edu

April 2024

Suggestions for Incorporating Artificial Intelligence in Ph.D. Student Training in the Field of Accounting

Abstract

Artificial intelligence (AI) is transforming academia by providing accessible and user-friendly generative models that can revolutionize Ph.D. student training. Increasing resource constraints may negatively impact the number and availability of Ph.D. faculty mentors, providing impetus to utilize AI tools to increase the efficiency of Ph.D. student training. This paper introduces a curated set of AI tools that Ph.D. students can use to enhance their learning process and research productivity. The primary goals of this paper are to promote a discussion about the responsible use of AI in accounting Ph.D. curricula and to increase the level of fairness between Ph.D. students at well-funded and economically less well-off programs. By offering practical guidance on using AI, we aim to empower all researchers to work more efficiently and have a greater impact regardless of the resources available in their Ph.D. program.

I. INTRODUCTION

The advent of Artificial Intelligence (AI) unleashes transformative possibilities with the potential to redefine teaching, learning, research, and practice within accounting. Accordingly, Ph.D. student training will need to evolve to meet the demands and capabilities presented by this new technology environment. This paper addresses the following questions related to AI and Ph.D. student training: How can Ph.D. students in accounting ethically leverage AI to enhance their effectiveness and efficiency on their path to becoming impactful researchers? Additionally, how can the profession utilize AI to promote greater equity among Ph.D. students from institutions of varying sizes and economic resources?

Many accounting programs are witnessing a decline in enrollments (Dawkins 2023), adversely impacting budgets. Such budget constraints, in turn, may negatively impact tenure-track faculty headcount and/or require existing tenure-track faculty to take on more responsibilities as the number of non-tenure track faculty declines. This trend places increased pressure on Ph.D. students to compete for more scarce faculty time (Cardilini et al. 2021). AI can help mitigate this dilemma by providing the possibility of electronic mentoring and allowing for more efficient use of faculty time when faculty and students interact.

In this paper, we offer guidance for Ph.D. students on using AI to enhance their research productivity in a pedagogically sound and ethically responsible manner. We begin by analyzing the research process to identify tasks where Ph.D. students could employ AI in their training and research efforts. This analysis has led us to identify five key research-related areas, where AI can offer significant assistance to Ph.D. students. These areas are 1) literature search, 2) data collection, 3) statistical analysis coding, 4) writing support, and 5) presentation preparation.

We evaluate AI tools in each of these five areas using four criteria, which are functionality, learning requirements, accessibility, and cost. Functionality pertains to a tool's usefulness for accomplishing specific tasks. An AI tool is deemed to be functional when it helps Ph.D. students accomplish a task without hindering the necessary learning progress. Learning requirements reflect the time investment necessary to achieve proficiency with a tool. Accessibility indicates the availability of a tool on IT platforms commonly accessible to Ph.D. students. Cost considers the economic resources required to use an AI tool.

We focus on tools that are functional, user-friendly, accessible, and either free or available at a comparatively low cost. An overview of the capabilities of these curated AI tools categorized by the five research areas is presented in Table 1. We also highlight the differences between free and premium service levels for these AI tools, where premium features are available at a cost.

This paper contributes to accounting literature by first dissecting research as a process, which aids in identifying tasks that Ph.D. students as researchers perform that can be enhanced or automated by using AI. By doing so, we hope to contribute to a discussion on which tasks Ph.D. students can delegate to AI and which should, for pedagogical or ethical reasons, remain in their hands. For example, while AI can competently generate text, Ph.D. students need to be mindful of when to use AI in this capacity, as developing writing skills is crucial and overly outsourcing the writing task impairs learning of this crucial skill. By dissecting the research process and suggesting areas where AI can support Ph.D. students, we hope to initiate a conversation on the implications of AI for Ph.D. student training and the integration of AI tools into Ph.D. curricula.

Furthermore, this paper aids the literature by spotlighting technical tools available and beneficial to Ph.D. students. We offer practical advice and clear instructions on how to use these tools, which is particularly vital for Ph.D. students at less affluent institutions, who commonly are not only part of smaller cohorts, but also often face greater teaching demands and thus have more constraints on their time. By providing this guidance on AI, we aim to highlight how AI can be used to democratize education (Bello 2023) - leveling the playing field between students from institutions with different economic means. Facilitating early adoption of these tools for Ph.D. students facing time constraints promotes long-term benefits, as many AI tools adapt and learn from user preferences over time and yield greater productivity gains with earlier career adaption.

Moreover, we provide students with ethical guidance regarding the responsible utilization of AI tools within their research strategies. We strongly advocate for Ph.D. students to employ AI in a manner that is ethical and does not hinder their learning process.¹ In instances where an excessive reliance on AI may have adverse effects on building essential skills, such as in the domains of literature summarization and text generation, we propose a supplementary approach rather than substituting their own work for AI generated output. This entails students utilizing AI to assess and improve the quality of their own work, rather than delegating tasks within these areas to AI at the cost of failing to acquire fundamental research skills.

In addition, our paper informs faculty, in line with the 2020 Guiding Principles and Standards for Business Accreditation, which states that “all AACSB-accredited schools will be expected to have processes in place to ensure that both learners and faculty are competent with

¹ The tension between the ethical cost and productivity benefit of AI is widespread (Dergaa, Chamari, Zmijewski, and Ben Saad 2023; Kim 2023; van Dis, Bollen, Zuidema, van Rooij, and Bockting 2023). The literature in disciplines ranging from accounting to biology identify this tension and, in some cases, elaborate on practical outcomes. We extend this literature by proposing a practical benefit and implementation strategy.

current and emerging technologies” (AACSB 2023, 22). Indeed, recent AACSB communications urge business educators to prepare learners for the opportunities and risks associated with AI technology (AACSB Thought Leadership 2023). By highlighting AI's capabilities, senior faculty can adapt their seminar teaching styles to ensure optimal use of time and resources in Ph.D. training. We also highlight how academic institutions and professional bodies can support the process of establishing AI in Ph.D. curricula.

Lastly, this paper details the potential costs associated with various AI services. This information is crucial for administrators, especially at schools that are facing budgetary challenges, to make economically responsible decisions in a rapidly changing technological landscape.

II. BASICS OF AI

AI is a comprehensive field within computer science dedicated to creating machines, systems, or software capable of performing tasks that typically necessitate human intelligence. AI is not one technological program or application but an array of approaches that includes various techniques and methodologies, such as machine learning², neural networks³, natural language processing⁴, computer vision, and more. A notable advancement in AI is the emergence of generative AI, which involves AI techniques and models designed to generate new content or

² Machine learning uses data and algorithms to imitate learning to gradually improve accuracy (Mishra and Gupta 2017).

³ Neural networks are a subset of machine learning. They describe the technique of adjusting regression weights and biases to minimize errors (Mishra and Gupta 2017).

⁴ Natural language processing (NLP) is defined as a collection of computational techniques for automatic analysis and representation of human languages, motivated by theory (Chowdhary 2020). While there are many technical applications of NLP, we refer exclusively to online information retrieval, aggregation, and question-answering applications.

data akin to human-made creations.⁵ These models are capable of producing work that is both creative and realistic (O’Leary 2022).

In terms of generating output, AI operates differently than, for instance, Google. While Google matches a search query to an answer, AI is not limited to one specific source. Instead, it derives its answers to user questions from a neural network. The responses generated by neural networks are influenced by weight factors that connect the content within the network. These weight factors are derived from the data on which the system was trained, and they contribute to the uniqueness of a particular AI platform. These weight factors can also change over time as the AI is trained on new data. As a result, AI responses tend to vary over time and in different contexts.

Presently, several prominent AI chatbot platforms are available to the public, with ChatGPT being one of the most recognized, alongside others such as Google's BERT (O’Leary 2023). ChatGPT's popularity stems from its ease of access, including its availability as an app on Android and iOS devices. Training large-scale models like ChatGPT is a complex and resource-intensive endeavor. For example, GPT-4, the latest version of ChatGPT, was trained using approximately 25,000 Nvidia A100 GPUs for 90–100 days at a cost of around 100 million dollars.⁶ The expenses and operational hardware requirements for training full-scale AI models are projected to escalate to several hundred million dollars by 2030, potentially limiting the number of comprehensive AI platforms available to users.

⁵ Currently, most AI systems are defined as ‘competent AI’, which means they are better than 50 percent of humans at a well-defined set of tasks. The goal of ChatGPT, for instance, according to its mission statement, is to achieve ‘artificial general intelligence’, which would mean the AI outperforms humans in performing a wide range of tasks.

⁶ The NVIDIA A100 GPU is a graphical processing unit (GPU). This data-center grade component is manufactured for the specific purpose of building large-scale machine learning infrastructure.

This paper focuses on ChatGPT and AI tools that are built on ChatGPT due to the platform's widespread availability. Developed by OpenAI, ChatGPT is part of the GPT (Generative Pre-trained Transformer) series. The latest version, ChatGPT-4, is the largest model with 1.7 trillion parameters, which are the numerical values that determine how a neural network processes and produces data (IBL News 2023, Shevchuk 2023).⁷ OpenAI provides Application Programming Interface (API) access to ChatGPT, thereby enabling developers to incorporate the model into their applications and services.⁸ Consequently, many services tailored to specific tasks, especially for academics, are built on ChatGPT's framework. A great number of tools that build on ChatGPT can be found in a ChatGPT store that was started in November of 2023, which is accessible at <https://gptstore.ai>.⁹

OpenAI, the company that runs ChatGPT, was founded in December 2015 as a research organization and technology company focused on artificial intelligence. It began as a non-profit entity but has since shifted towards a profit-oriented structure, accepting investments from firms such as Microsoft, acquiring other companies, and commercially licensing its technology (OpenAI 2023a).

It is important to note that AI progresses at a rapid and more accessible pace compared to the development of other technologies (MIT Technology Review Insights 2021; News News 2023).^{10, 11} This presumably is because AI has the ability to self-improve as it is a self-learning

⁷ ChatGPT-3.5 (Free) is available for \$0. ChatGPT-4 (Plus) is available at \$20 for a monthly subscription (<https://openai.com/chatgpt>).

⁸ API allows systems to communicate with other systems to access their data, services, or features. This interface is vital for different software packages to have the ability to connect.

⁹ The ChatGPT store was introduced in November 2023. It is akin to the Apple app store for the ChatGPT universe.

¹⁰ For instance, for this paper, we had to re-write the description of several AI tools within a short period of time due to the rapid emergence of new technological capabilities within tools.

¹¹ A survey conducted by Resumebuilder.com among 1,000 managers revealed that 6 months after the public release of ChatGPT, 49 percent of the companies were already utilizing it, with an additional 30 percent planning to adopt it in the future (Resume Builder 2023). This rapid market penetration is rarely observed with other technologies.

system. This means AI has the potential to recognize and fix its own weaknesses. Additionally, AI is now being used in areas relevant to its progress that previously relied solely on human input. An example of this is AI's involvement in creating improved microchips that are required for running AI applications (Synopsys 2023). Given this rapid growth, AI's capabilities for research will continuously improve. Therefore, whether it will become necessary to use AI in Ph.D. student training is not a question but a forgone conclusion. We are only left to decide how quickly we will embrace the use of AI in Ph.D. training and to make choices about how AI will be used.

III. RESEARCH AND AI

Current State of Literature on AI in Teaching and Research

To inform our selection and suggestions on the use of AI tools for Ph.D. students, we conducted a literature review on the use of AI in higher education. In March 2023, Applebaum et al. (2023) surveyed 109 accounting professors to explore the impact of ChatGPT in the classroom, including Ph.D. programs. The survey revealed that students far outpace educators in adopting AI, using it for tasks such as completing written assignments, asking technical questions, and supplementing course materials. In comparison, educators and institutions have been slow in adopting and establishing policies to regulate the use of AI in the classroom (Kim Merrill, Xu, and Sellnow 2020).

When it comes to research, the adoption of AI as a new technological tool presents both opportunities and ethical challenges. Research has identified several opportunities, including improved literature processing efficiency, reduced bias, increased research dissemination, and enhanced communication quality (Lund et al. 2023). For example, AI can assist researchers to avoid potential biases by providing a means to identify supporting and contrasting evidence in a

prompt and accessible manner (Stokel-Walker 2023). Additionally, ChatGPT can facilitate clearer communication by researchers.¹² Furthermore, AI through natural language processing can also be essential in helping researchers process the ever-growing volume of data available to researchers (Beath, Becerra-Fernandez, Ross, and Short 2012).

However, using AI for research presents several ethical threats, including inaccuracies, perpetuating bias, copyright and plagiarism violations, and the risk of inadequate citation of information sources (van Dis et al. 2023). For instance, AI frequently produces incorrect information, sometimes referred to as hallucinations. In addition, AI makes crediting original ideas more challenging. For example, the popularity of Google Scholar has resulted in the Matthew Effect, where highly cited articles receive more credit than less-cited ones. As a result, new studies sometimes improperly cite the most popular article as a primary source instead of crediting another potentially earlier paper, perpetuating inequalities in research practice (Lund et al. 2023).

Our contribution to the extant literature on AI in academic research focuses on exploring how AI can specifically enhance Ph.D. training, a topic previously unexplored. This investigation is pivotal for several reasons.

Firstly, AI has the potential to introduce a greater level of equity among Ph.D. students across institutions with different economic resources. For example, AI can provide low-cost or free proofreading services, a resource that was traditionally expensive and not uniformly

¹² Through simple prompts, ChatGPT can be used to provide copyediting services. The authors of this paper tested this capability by using ChatGPT to improve the clarity of the writing of some sections of this paper. While the authors wrote all original content, ChatGPT was instructed to edit the paper for grammar, spelling, and conciseness of speech. Sections edited by ChatGPT were then carefully reviewed by the authors. Author (human) efforts were necessary to further craft the text of the manuscript to achieve the final submitted content.

accessible to all Ph.D. students. By educating students about AI's capabilities in this and other regards, we contribute to a more equitable academic environment.

Secondly, the academic accounting community must acknowledge and explore AI's capability to change Ph.D. student training. The transformative nature of AI and its impact on research productivity is undeniable. Accounting academia does not operate in a vacuum. It competes for resources with other entities within and outside of business schools that often utilize AI to boost their productivity. Consequently, our effectiveness in incorporating AI into Ph.D. training will inevitably influence our graduates' productivity and their competitiveness for tenure-track positions.

Lastly, while AI presents numerous opportunities to enhance productivity, it also poses ethical and pedagogical challenges concerning its appropriate usage. As a profession, it is imperative that we educate ourselves about AI's capabilities to facilitate an informed dialogue around establishing ethical and pedagogical boundaries on AI usage in Ph.D. training.

Ph.D. Student Research as a Process

Research is a systematic and methodical process involving the investigation, study, and collection of information, data, and knowledge to address questions, solve problems, or gain a deeper understanding of a specific topic. This process commences with the formulation of a research question or problem. It proceeds with a comprehensive review of existing literature, followed by the development of a research model to test hypotheses, data collection, data analysis, and ultimately, the presentation of research findings in communicative form, often in the form of presentations and papers. It is worth noting that the research process is not strictly linear and often involves iterations, adjustments, and refinements along the way.

AI can play a crucial role in various facets of the research process, augmenting efficiency and productivity. In this paper, we focus on specific segments of the research process where AI can be a valuable asset. These segments include (1) literature search and summarization, (2) data collection, (3) statistical analysis, (4) writing support, and (5) presentation. In these areas, AI can be used to improve Ph.D. student efficiency and productivity within the technological constraints that Ph.D. students commonly face (e.g., students are unlikely to be able to run complicated customized language models in the near future), without impairing the learning of key skills as a researcher, and without violating ethically acceptable boundaries.

For literature search and summarization, AI-powered search engines and recommendation systems can expedite the discovery of relevant literature, articles, and papers, particularly benefiting Ph.D. students who are still immersing themselves in the literature. AI can also assist in summarizing and organizing extensive text, facilitating the extraction of key insights from existing research.

For data collection, AI can not only serve as a training tool for facilitating discussions on data collection methods, but also guide researchers on how to conduct data collections. While AI has extensive data collection capabilities, this paper focuses on basic AI data collection support suitable for Ph.D. students at various research institutions, emphasizing feasibility in terms of time commitment and budget constraints. The application of more sophisticated AI tools for data collection, such as bots, is expected to remain limited for Ph.D. students for the foreseeable future.

For statistical analysis, AI can offer substantial support by providing emerging researchers with guidance on data analysis. AI goes beyond the capabilities of traditional search

engines, not only offering information about statistical tests but also assisting students in executing these tests within software platforms. Detailed guidance, along with highly relevant example codes, can help students understand which tests to conduct, their expected outcomes, and how to perform these tests. AI can even help resolve error messages from statistical software packages when running statistical tests.

For writing support, AI's ease of use in generating text makes writing one of the most accessible AI functions. However, caution is essential when utilizing AI for writing. While AI has the capability to generate text, an over-reliance on such features may deprive Ph.D. students of the valuable learning experiences required to develop essential communication skills. Moreover, utilizing AI to generate text and presenting it as one's own work raises serious ethical concerns, which are not befitting for a Ph.D. student in the field of accounting (or any academic researcher). Nevertheless, Ph.D. students can leverage AI for guidance on structuring and presenting logical arguments (e.g., assistance with outlines) and for proofreading to enhance their communication skills. Therefore, we present AI's role in writing as a support tool in this paper.

For presentations, it is possible to use AI to generate entire presentations. However, again an ethical dilemma arises. Presenting AI-generated presentations when AI has been involved in text generation as one's own work is not ethically acceptable. Nevertheless, AI can be used in a supportive role to create presentations by providing guidance on structuring and formatting, or as a tool for generating useful illustrations, which we deem acceptable usage – particularly when the presenter gives appropriate credit to the source of content within the presentation.

IV. AI TOOLS FOR PH.D. STUDENT RESEARCH

Method of Identifying AI Tools Beneficial for Ph.D. Student Research

The primary objective of this study is to select and discuss a set of AI tools that can effectively enhance the efficiency of Ph.D. students in accounting in the areas that we previously defined. This section outlines the methodology employed for the systematic selection of these AI tools.

We conducted a comprehensive literature review and web search to identify existing AI technologies and their application potential in research. Additionally, we consulted web crawler tools that provide an organized presentation of available AI tools. Specifically, we utilized two aggregator tools: <https://topai.tools> and <https://thereisanaiforthat.com>. Topai.tools offers supervised indexing of AI tools, ensuring that the tools presented pass through a screening process to exclude non-AI tools. In contrast, thereisanaiforthat.com employs an unsupervised indexing process, with ChatGPT categorizing AI tools. Lastly, we scouted the ChatGPT and plug-in store, which is accessible at <https://gptstore.ai>.

Following the initial identification, we conducted a thorough evaluation and selection of AI tools to be presented. This evaluation and selection were based on four key factors: functionality, training requirements, accessibility, and cost.

Functionality refers to assessing the tool's capabilities in terms of meeting useful and acceptable objectives. The primary criterion is whether an AI tool accomplishes an intended and useful task, with particular emphasis on accuracy. Accuracy refers to the correctness of AI-generated output.¹³ A technically focused and popular measure of functionality is uptime (i.e., the proportion of time a tool is available to end users; the opposite of downtime), as some AI

¹³ Large language models can produce inaccurate responses through what are called hallucinations. AI hallucination is a phenomenon where AI generates a convincing but completely made-up answer. OpenAI's notes acknowledge that the answers generated by ChatGPT may sound plausible but be nonsensical or incorrect (Athaluri et al. 2023).

tools are more responsive than others or become less responsive at peak usage times. We prioritized tools that distinguish themselves through consistent uptime.

Our second factor, training requirements, evaluates the level of training necessary to effectively use a tool. A tool that is easy to use has little to no training requirements for its application by a Ph.D. student beyond basic computer fluency skills. In most cases, the user simply needs to access a web page to use the AI tool.¹⁴

Our third factor, accessibility, assesses the tool's availability, ease of installation, and compatibility with computer platforms commonly available to Ph.D. students in the accounting field.

The final factor in AI tool selection is cost. Our focus is on free-of-cost or low-cost AI tools. Many AI tools are available for free. Some AI tools require month-to-month plans or offer discounted yearly subscriptions. The scalability of an AI tool, where usage might generate fees, but initial access by the individual user is available without upfront costs, is particularly advantageous.

In selecting tools, we prioritized those that offer valuable capabilities, can be used without extensive training, run on commercially available computers, and are either free or low-cost (see Table 1).

V. AI TOOLS

AI and Literature Search and Summarization

¹⁴ We acknowledge the limitations of a web-based AI tool where little is known about the development of the AI model. Studies such as Xu and Babaian (2021) advocate for an “integrated AI curriculum”, where a basic understanding of how AI works is taught alongside relevant functional topics as part of the business school curriculum. This approach, while pedagogically sound, will take time to impact the prerequisites of the Ph.D. program. We address this gap by providing AI exposure with ready-to-implement tools.

AI can be particularly useful for literature search and summarization (Jones 2023), which are often primary tasks assigned to Ph.D. students with the objective of developing an understanding of the current state of research. We present the following literature search tools that offer various strengths, ranging from identifying relevant literature and extracting information from papers to presenting interconnectedness between studies. In our review of AI literature tools, we identified several noteworthy common usage themes.

The first theme is that of digital personal libraries. Many AI literature search tools build libraries where the AI learns from user preferences. AI surpasses traditional search engines in this domain because AI learns from a user's preferences and can independently update searches. This means the AI tool trains on the user, learns the user's interests, and automatically finds and suggests literature based on these preferences. Every AI tool we discuss for literature search and summarization includes readily accessible search functionality that makes it easy to look up a validated reference, regardless of where you are in the literature search process. Given the ability of these tools to learn from usage and progressively build a repository of literature, an early career adoption of these tools can yield long-term benefits.

A second usage theme is what we term the "citation sprint". This refers to the ability of AI to rapidly navigate among citations, references, and links to related papers within a library or database. AI significantly enhances this process because it can independently recognize relationships between different papers.

A third theme is the integration of various tasks within AI literature access tools. For instance, AI tools allow researchers to use a single application to scan a paper, automatically summarize it, add it to a library in an organized fashion, sort it quickly by various flexible criteria, and place it in the context of the broader literature. Moreover, AI facilitates the

understanding and interpretation of articles. Many AI literature search tools also allow the reader to ask AI questions. This means that AI can facilitate the understanding of an article by providing answers related to the article for questions that the reader might have.

The fourth usage theme is the unique advantage of AI to independently discover relationships between different research topics based on various criteria. This strength can be deployed in the context of visualization tools. For a body of literature, AI visualization tools can graphically demonstrate its evolution over time, connections between research articles, gaps that exist in topical coverage, and highlight areas receiving recent attention.

Semantic Scholar

Semantic Scholar is a literature search engine that can serve as a Ph.D. student's primary academic literature search instrument. The tool provides an AI-powered search that uses natural language processing (NLP) to sort publications by meaning and context. In recent years, Google Scholar has been the choice of many as an academic search engine. Google Scholar works by matching keywords to content. In comparison, Semantic Scholar goes beyond such matching by establishing deep semantic connections between papers to provide research-relevant results. This allows a researcher to find research papers that are semantically similar (i.e., similar in meaning) in response to a search query (Polonioli 2020). Additional features include citation analysis and research feed notifications.

The traditional literature review process, which typically involves searching, filtering, and skimming until a relevant sample of papers is collected, can be time-consuming. Semantic Scholar offers a more pertinent search, thereby enhancing efficiency.¹⁵ Ph.D. students can save

¹⁵ In our experience, Semantic Scholar can be used very efficiently in conjunction with Google Scholar. When a research question is defined, a Google Scholar search can help to capture an initial set of relevant research papers. This content can be fed into Semantic Scholar, which can build upon the search with results that yield a complementary set of papers for review.

time by maintaining a personal research library within Semantic Scholar. Integration with the open-source reference management software, Zotero, facilitates the creation and management of libraries.¹⁶ Once a personal library is established, Semantic Scholar initiates a research feed based on selected papers or topics, delivering periodic updates via email. The library and research feed pages are shown in Panel A of Figure 1. Semantic Scholar is a free service and there is no current indication that there will be a charge for access.

Consensus

Consensus is an academic literature search tool that draws its source material from the Semantic Scholar database. Unlike Semantic Scholar, Consensus does not require exact keyword matches in search queries but uses plain English questions as prompts, with the machine learning model providing results. Keywords from the user's question are used in combination with a vector search¹⁷ to identify relevant papers. In addition to relevance, the ranking of papers appearing in the search output is further informed by metadata, which includes information on items such as citations, publication date, and study design (Consensus 2022).

For Ph.D. students, Consensus bridges the gap between literature search and summarization by allowing the user to ask research questions in natural language. This enables access to quality research from different fields, even if the user is not familiar with the keywords used in those disciplines. In addition to the natural language search, the software provides summaries with snapshots of each paper, offering various types of information such as study

¹⁶ Zotero is an open-source reference management software designed for organizing bibliographic data and associated research materials, including PDF files. It offers various functionalities, including web browser integration, online synchronization, and the ability to create in-text citations, footnotes, and bibliographies. Zotero also includes an integrated PDF reader and note editor. Additionally, it integrates seamlessly with widely used word processors like Microsoft Word, LibreOffice Writer, and Google Docs. For more information about reference managers see Perkel (2020) and Francavilla (2018).

¹⁷ A vector search uses machine learning to capture the meaning of unstructured data, such as text. It facilitates semantic search, allowing for a search to yield results that are based on overlapping meaning rather than simply on identical use of keywords (Elasticsearch 2023).

type and citation quality rankings. The software also features a “Consensus Meter” that summarizes the research's position on user-generated questions, categorizing them as “yes”, “no”, or “possibly”. An example of the search summary, snapshot, and Consensus Meter is found in Panel A of Figure 1. Although Consensus’ interpretation of the state of research may sometimes be oversimplified, it serves as a valuable starting point for assessing the literature related to a particular question.¹⁸

Consensus is currently offered for free with limited paper summary capabilities, Consensus Meters, and snapshots. A free plan comes with 20 credits per month, with each search, summary, Consensus Meter, or snapshot costing a credit. A premium plan for students is available with unlimited credits for summaries and Consensus Meters for \$10 for month-to-month access or \$84 annually.

SciSpace

SciSpace is a tool that goes beyond literature search and enhances the research workflow by summarizing articles. Its interface includes four main components: Library, document review, Copilot panel, and Semantic Scholar integration. A library feature, again integrated with the reference management software Zotero, eliminates the need for managing multiple bibliographic databases. Documents are viewed in a large-format panel, where text can be highlighted, annotated, and exported. The Copilot panel, adjacent to the document viewer, supports requests for explanations, summaries, and external references using article text or the entire Semantic Scholar corpus by entering text requests. Screenshots of these features are shown in Panel A of Figure 1.

¹⁸ For example, the user can ask Consensus “Does creatine improve cognition?”. The software will provide the number of papers analyzed in response to that question and a percentage response for papers that answer the question in the affirmative, deny the claim, or indicate a possibility. This tool can provide emerging scholars with a quick understanding of the position of the literature on certain questions.

The ability to upload a pdf and have AI provide answers based on its content allows students a more immersive interaction with the paper that enhances learning outcomes. The AI integration essentially allows for a seminar-like conversation about key takeaways from a paper of interest. SciSpace offers this in an environment that allows reading, annotation, and reference gathering to occur simultaneously and on the same screen. For example, students can highlight text, note concerns, and request context from the Copilot without having to leave their current place in the paper.

SciSpace is available for free for limited use of the document review, Copilot panel, and paraphrasing tools. The free version uses what it calls a “simpler model” than the model used by the paid version. A \$20 month-to-month subscription has access to “premium” models and unlimited use of the research tools. Annual subscriptions are \$144.

Elicit

Elicit is another AI tool that helps with literature summarization. Elicit provides literature review summaries in an interactive table of research attributes. When a research question is queried, relevant research papers are presented in tabular form. The table is arranged by research attributes such as dependent variable measures, sample sizes, hypothesis testing methods, and future research suggestions. A screenshot of the Elicit literature review table is shown in Panel A of Figure 1. Elicit uses natural language processing to extract and summarize this information from a paper.

Ph.D. students can use Elicit’s AI-enabled review summaries to compare different papers across custom attributes. Elicit distinguishes itself with an easy-to-use platform, and it has a desktop application that simplifies the integration of a personal library.

Elicit works on the credit system, where each user is allowed to spend a certain amount of credits per month. The free version comes with 5,000 credits each month. For \$12 a month, users receive an additional 12,000 credits and the capability to download results and citation data. Each element of the tool requires different amounts of credits for its use. A simple search will cost less than 100 credits. Uploading a paper for a summary will cost 100 to 500 credits. Comparing papers across a common research question will cost 500 to 1500 credits. From a Ph.D. student's perspective, paying only for usage may be appealing.

Scite

Scite is an AI tool that helps users see connections between different papers. It does so through a dashboard that offers a visual organizer. The dashboard allows drilling down into a specific project, which reveals the number of publications, types of citations, editorial notices, and a citation quality measure known as the “Scite Index”. The AI assistant supports Q&A searches, allows references to be exported to Zotero with a single click, and provides summaries for research questions and abstracts. The extent to which summaries are supported by quality references is shown in Panel A of Figure 1.

Exploratory research often involves a “reference crawl”, where related publications are identified through cited references—an activity well-suited for an AI tool like Scite. In this platform, “Smart Citations” displays counts of supporting and conflicting references as in-line visualizations, aiding Ph.D. students in understanding citation and journal quality. Scite is available by subscription only.¹⁹ The provider offers a \$20 month-to-month plan or a \$144 annual subscription.

Connected Papers

¹⁹ Scite offers a one-week free trial. At the time of this writing, the trial was followed by a 40 percent discount offer for a 12-month subscription.

Connected Papers is an interactive tool that provides a visualization of connections between research papers through citations and references. Starting with a central paper, it draws from a database of over 50,000 papers and selects a “few dozen” with the strongest connections to the central paper. It then provides a visualization that maps preceding and derivative works, with each paper appearing as a circular node. Papers are grouped such that closer proximity indicates greater similarity. The size and shading of a paper’s node vary according to the paper’s recency and impact. Hovering over a paper’s node highlights its citation lineage, revealing the development of research leading to the selected paper over time. An example of the Connected Papers visualization tool is shown in Panel A of Figure 1.

Scholarly publications do not exist in isolation but form a web of knowledge. Connected Papers visualizes this web, enabling Ph.D. students to see the relationships between papers. Given that it provides a fairly comprehensive visualization of the most closely connected research in a particular area, it is useful in determining the key papers relevant to a research question of interest. By grouping papers based on similarity, Connected Papers also helps to identify papers that address relatively unique aspects of a research area (i.e., papers on the fringe of the web that are not as closely connected to others). As such, this tool can be used to identify areas where additional research is potentially likely to have a greater incremental impact, which is a useful consideration when one is attempting to identify novel research projects. Conversely, less dense portions of the visualization could also indicate areas where there is difficulty in data collection or some other methodological reason for being cautious in pursuing a project (Jones 2023).

Connected Papers offers annual plans for individual or group academic use. Both individual and group plans are priced at \$60 per user for a year.

Research Rabbit

Research Rabbit is another visualization tool for exploring papers that share a common topic, citation, or author. Research Rabbit stands out for its ability to maintain and manipulate a personal library, and it can be integrated with Zotero. A user starts a collection by selecting a paper or papers that seed the visualization, with Research Rabbit drawing from AI to extend the visualization based on related works. The user can add papers to a collection, and the tool will incorporate these additions into the visualization. AI learns from user inputs and adapts its recommendations accordingly. The user can set up notifications to learn when Research Rabbit has identified new research related to a saved collection. Research Rabbit also allows users to share collections with others and interact within shared collections via comments.

As with Connected Papers, identifying gaps in the literature represents research opportunities. Research Rabbit's value lies not only in visualization but also in its ability to showcase interdisciplinary connections, highlighting literature that has transcended departmental boundaries to pioneer new paradigms. We suggest that Ph.D. students use Research Rabbit to extend their knowledge of a working research topic into related papers and authors through the visualization tool. Research Rabbit is free and does not subject its users to advertisements or offers of additional functionality conditional on a premium plan.

AI and Data Collection

AI can help Ph.D. students collect data more efficiently across behavioral and archival methods. For archival work, ChatGPT can help with generating, troubleshooting, and optimizing code that performs the data collection. For behavioral research, ChatGPT can help with generating research instruments and improving the quality of research instruments.

We explore ChatGPT's role in collecting both archival and behavioral data. While ChatGPT can streamline data collection in other roles, for instance as a bot, such programming would require substantial effort beyond the reach of most Ph.D. students. Hence, our focus is on AI's supportive role.

ChatGPT for Archival Research

ChatGPT can significantly enhance accessibility to programming languages for Ph.D. students. In modern Ph.D. programs, students aim to master Python, SQL, R, SAS, STATA, and SPSS. ChatGPT offers language-specific code generation through natural language prompts. AI is unique in that it can assist in generating code for data collection and help troubleshoot error messages that students might encounter while attempting to run their code.

An example of a comprehensive application showcasing the capabilities of AI in archival data collection is provided by faculty at Brigham Young University through the Advanced Accounting Coding Camp (<https://www.accountingcodingcamp.com>). This example utilizes SEC data and employs a web scraping procedure. In this instance, ChatGPT provides Python code for scraping financial data from the EDGAR website. Utilizing a Chain of Thought (CoT) prompting approach that guides the AI through step-by-step processing, a complete program is developed for data collection and analysis (see Wei et al. 2022 for more information on CoT prompting in LLMs). Similarly, the Advanced Accounting Coding Camp includes an exercise on prompting ChatGPT to generate SAS code for interfacing with the Wharton Research Data Services (WRDS) platform, thereby enhancing research efficiency for Ph.D. students.

Prompting in ChatGPT involves creating a task description, directing the task, and setting an expectation of the response. The CoT prompting approach accomplishes this through intermediate reasoning steps. It is one of several techniques suggested under the prompt

engineering discipline (Giray 2023). Single-shot prompts do not provide enough context to narrow ChatGPT to a specific, usable response. Few-shot prompts provide context and the opportunity for the user to train responses as sufficient or insufficient.

ChatGPT for Behavioral Research

ChatGPT can be useful to generate research instruments for behavioral research. For instance, ChatGPT can facilitate the creation of post-experimental questionnaires (PEQs). ChatGPT's effectiveness for that purpose depends on the quality of the user prompts.

As an example, when tasked with creating task enjoyment questions for an accounting study, the specificity of our prompts directly influenced the utility of the results. We started with a general prompt that produced mediocre questions, while a more detailed prompt yielded surprisingly useful questions.²⁰ Table 2 illustrates the Chain of Thought (CoT) prompting technique, which is utilized to enhance the response of a large language model to a query.

While ChatGPT can produce valuable output when it comes to generating instruments, we encourage students to use such output as a starting point to be built upon with additional research. For instance, for a PEQ a Google search of any AI provided questions can lead to validated instruments, which may offer a higher likelihood of successful data collection, as these have been used in prior studies and are recognized by the research community.

ChatGPT can also be a valuable tool for proofreading or copyediting participant instructions. A particular strength of ChatGPT is that it allows for seamless alteration of the

²⁰ As a starting point we told ChatGPT to create questions using the prompt "create questions for task enjoyment in accounting research", which yielded mediocre results. In a second attempt, we reformulated our instructions to contain more information. The prompt we used was "create questions to measure participants' task enjoyment for a research study", which yielded better results. However, in an additional step, we added even more detail and used the prompt "what questions does managerial accounting research ask research participants to measure task enjoyment". This prompt to ChatGPT yielded surprisingly useful results. This demonstrates that precision matters for ChatGPT prompts and adding additional detail in the prompt to ChatGPT can be useful.

language used, which, for instance, allows for the generation of language that may be more readily comprehensible for young adults.²¹

AI and Statistical Analysis

AI offers several ways to enhance statistical analysis. At early stages of Ph.D. training, it can assist with fundamental statistical knowledge. ChatGPT serves as a valuable resource for general inquiries such as: “What is an ANOVA test?” or “How do I interpret regression results?”. A simple prompt about how to perform factor analysis in SPSS is included in Figure 1, Panel B. Users can input data, provide study context, and inquire about appropriate statistical inferences. The savvy ChatGPT user can apply the Chain of Thought (CoT) prompting method to guide the model toward providing a comprehensive explanation. AI's advantage over a traditional web search is its capacity for continued dialogue and clarification through follow-up questions.

AI also assists with statistics software. It can generate step-by-step instructions for running specific tests in popular tools like SPSS, SAS, Stata, and MatLab. An example prompt about importing Excel data into SAS is included in Panel B of Figure 1. AI offers learning advantages over a simple web search by providing detailed examples and instructions for executing tests in the desired statistical software package. If a tool's native scripting language is needed, ChatGPT supplies the required script in an easy copy-and-paste format (Shoufan 2023).²²

²¹ A particular strength of AI is that it can adapt output to different communication styles. This means that it can present output, for instance, in a rather humorous form, sounding like a comic character (e.g., Larry the Cable Guy), or in a more serious form. It can also simplify language specific to a target audience (e.g., use simplified language appropriate to young undergraduate students), thereby increasing the certainty of comprehension of any instructions or questions.

²² ChatGPT responds to programming language queries with a response in natural language and a response in the relevant programming language. The “code blocks” or “code examples” are structured segments of code containing variable definitions, control structures, library frameworks, and in some cases sample data that can be copied and pasted into the programming environment (OpenAI 2023b).

ChatGPT can generate scripts for a variety of data analysis and statistical programs, including SPSS, Stata, JMP, R, and Python. Additionally, computational plugins like Wolfram Alpha extend functionality beyond natural language processing, providing deeper associations between research questions and statistical expectations.

For more nuanced requests, such as specific code libraries or language idiosyncrasies, ChatGPT can offer tailored suggestions based on natural language processing. This approach benefits users with a solid understanding of language syntax and library functions. It is also useful for troubleshooting when error codes are encountered within a program. Error codes can be entered and ChatGPT will suggest solutions within the program's context.

Early adopters suggest that the CoT prompting technique is effective for beginning AI-powered code synthesis. Students can submit a sequence of instructions that detail the research question, variables, and dataset structure. This enriched input can enhance the effectiveness of future prompts and insights.

AI and Writing

Knowing how and when to use AI is critical. As described in the Wood et al. (2023) study where ChatGPT's performance was compared to that of accounting students, AI is best leveraged in tasks where natural language is the focus, such as writing. Generating text is a core function of ChatGPT and a technological strength of AI. However, finding *ethical* and meaningful ways to use a generative AI tool for writing is a challenge. In this section, we outline uses of AI for writing that we deem ethically acceptable and pedagogically meaningful.

AI can support the writing process in two ways. First, it can provide a suggested outline of certain kinds of texts that a Ph.D. student intends to write, which can be helpful to novice

writers who are unfamiliar with how to structure the presentation of a logical argument.²³

ChatGPT can easily be used in this function by using detailed prompts specifying the topic, the kind of text, and the target audience. For example, a detailed prompt may request the outline of a paper by research discipline and publication venue. Following up, a second prompt can request subheadings within each of the major paper sections (e.g., Theory and Prior Literature, Methodology). Finally, a prompt may request a summary of findings based upon a snippet of text or data, presented according to the structure provided from preceding prompts. Any AI assistance must be acknowledged in any resulting work or presentations, ensuring that the Ph.D. student maintains accountability to the wider research community.

Second, AI can be an invaluable tool for Ph.D. students when used in a proofreading and copyediting function. Ph.D. students, who often lack the financial resources to hire professional copy editors, can use ChatGPT as a free editing service (Kim 2023). When used in this capacity, AI creates a fairer competitive environment for students of varying economic backgrounds and different levels of English language proficiency (Huang and Tan 2023). Using AI in a copyediting function can enhance the accuracy and clarity of any written communication and can do so compared to human copyeditors at extraordinary speed. Using AI in a copyediting function not only improves the quality of the writing but allows the writer to work through a copyedited, clearer, and easier-to-understand draft after a very short period of time when using AI to proofread and copyedit text. This results in a speedier iterative work process, which can pose a significant improvement in the writing process for Ph.D. students. This also presents time saving opportunities for Ph.D. student advisors in that it reduces their workload when providing feedback on student drafts.

²³ Naturally, AI can only write a text about something that it is familiar with. AI has its limitations when it comes to generating novel insight, which is at the heart of many academic papers.

In the following subsections, we present AI tools and usage strategies focused on supporting the writing process in a proofreading and copyediting function, which we consider the most useful, ethical, and pedagogically responsible uses of AI for writing.

AI and Writing Support: ChatGPT

In GPT-4, ChatGPT has the capability to process complete documents and respond to inquiries related to uploaded documents.²⁴ When utilizing ChatGPT for the purpose of proofreading and copyediting, it is essential to employ an appropriate prompt that effectively guides the AI. A well-designed prompt should include three fundamental components: a clear definition of the AI's objectives, specification of the relevant context, and, if necessary, the imposition of suitable limitations.

When creating a prompt for copyediting, it is crucial to provide ChatGPT with instructions regarding the specific copyediting tasks required. It is important to note that the AI processes prompts with a high level of precision. For instance, AI distinguishes between proofreading, which mainly focuses on grammar, spelling, and clarity, and a copyediting prompt that implies more substantial revisions to the text. It is, therefore, important to choose the appropriate prompt to define the scope of the intended work. Specific areas of concern, such as 'grammar checks,' 'spelling checks,' or 'enhancing writing clarity,' can be explicitly addressed in a prompt. Additionally, a prompt should indicate that the text pertains to an accounting journal research article and ideally specify the target journal. Constraints should be established when appropriate to clarify the degree of changes expected from AI. It is particularly important to

²⁴ While an extensive discussion of the topic is beyond the scope of this paper, it is important to note that users should be wary when entering or uploading any content into ChatGPT or other AI platforms. ChatGPT saves prompts, questions, and content that users enter, and this data may be extracted by OpenAI to improve the chatbot's language model (Drapkin 2023). We strongly encourage Ph.D. students to do their due diligence prior to using any platform to determine what their privacy rights are, what options are available, and how their data might be saved or used.

manage the extent of any text shortening in initial drafts, as ChatGPT can be quite aggressive when cutting text, potentially resulting in a loss of nuanced communication. Applying constraints such as ‘trimming the excess’ typically reduces the text by only 5 percent, whereas ‘reducing verbosity’ may lead to a 30 percent reduction. It is probable that the first response will not capture all three prompt components on the first try. In fact, using progressive prompts to progressively create nuance in the language has been shown to improve results (Reynolds and McDonell 2021). In iterative prompts, adjust the objective, context, and limitations in a way that logically refines the language. Using a prompt of concision objective, for example, begin with the maximum amount of detail and length and work towards refining the language until too many details have been removed. Then back up a step.

To ensure effective proofreading and copyediting, we recommend using the following prompt structure: “*Assume the role of a professional proofreader and copyeditor for an academic accounting research journal article. I have a journal article that I’m planning to submit to ‘Issues in Accounting Education’, which is published by the American Accounting Association. Proofread and copyedit the article to ensure that article meets the highest standards of clarity, coherence, and grammar. If you notice any common errors or issues related to accounting terminology, provide suggestions or corrections to ensure accuracy in that regard. Review the following passage and suggest any corrections or improvements:*”²⁵

ChatGPT is best used in writing support where open linguistic context can benefit the writing (Lingard 2023). The strategy we suggest allows for the ChatGPT LLM to provide relevant specificity. ChatGPT provides language associated with a specific writing task within a

²⁵ It is important to note that the same prompt at different times and in different contexts can result in different responses. A practical fix to this issue is to use more precise prompts to avoid ChatGPT basing its response on different priors.

specific context with clearly stated limitations. While dedicated tools, discussed in the next section, are best for focused refinement of a document, ChatGPT, on the other hand, can expand the Ph.D. student's use of language in a specific way.

AI and Copy Editing using Dedicated Tools

While ChatGPT is suitable for proofreading and copyediting tasks, we highlight two tools that can greatly enhance the editing process.

The first tool is editgpt.app, which is available as a browser extension or within a web browser. This tool has the advantage of offering pre-set options for editing text. For example, it provides buttons to choose 'academic' writing, 'grammar' checking, or 'proofread' for light editing. This allows users to easily select an editing mode with a simple click, making it a user-friendly and efficient editing tool. Features of this tool are presented in the screenshot in Panel C of Figure 1. Editgpt.app is available free of cost with limitations on upload volume and functionality or as a paid service without these restrictions for a monthly fee of \$10.

The second tool is Isaac Editor, an AI-assisted word processor that offers grammar checks, clarity assessments, and paraphrasing tools. The user works in a web-based editor with much of the same functionality you get with a desktop word processor. Text is manipulated in blocks, similar to many web content management systems. Highlighted text can be summarized, paraphrased, expanded, and shortened. You can also use the editor environment to find cited sources relevant to selected text and generate an AI explanation of a selected area of text. The editing environment and highlighted text features are shown in Panel C of Figure 1. Though it has the potential for misuse (e.g., by using the AI generated explanation without appropriate attribution to the source), this tool can be a cost-effective first step in the copyediting process when used responsibly. Isaac Editor is free to use with minimal access to generative AI

functionality. A monthly subscription is available to academic users for \$11 with unlimited access to generative AI functionality and premium support.

AI and Presentations

AI can also be helpful when generating presentations. Generative AI can offer guidance on creating presentations and even create the presentations themselves. For instance, as a support tool, ChatGPT can outline how a presentation should flow, providing slide order and content suggestions. This guidance can be invaluable for a Ph.D. student who lacks experience in presenting research findings.

AI can also generate entire research presentations and we present a tool capable of this task. However, we strongly encourage Ph.D. students to not overly rely on AI when creating slide presentations because the act of determining an effective means of presenting one's research is a critical part of the learning process, and students should develop their unique style. For example, while AI struggles to introduce humor into a presentation, humor can be a powerful tool to increase an audience's receptiveness. Such a skill can best be honed when creating one's own slides.

Gamma for Research Presentations

As an example of an AI tool for research presentations, we present Gamma. Like many competitor products, Gamma operates within a web browser, where presentations are created, stored, and conducted. Gamma starts with a search query, from which multimodal AI (combining visual and text features) populates slide narratives based on a prompt. After a theme is selected, Gamma produces a cohesive presentation. The tool includes a chat panel for user comments and suggestions, and while text and images can be modified at the user's request, manual changes

cannot be made concurrently with AI suggestions. Gamma's functionality can be seen in Panel D of Figure 1. A presentation can be saved and then manually edited.

Gamma is most effectively used by Ph.D. students when the presentation topic is simple and general, such as a research proposal or a presentation for a non-expert audience. It does not handle complex prompts as well as ChatGPT. We recommend that students come to Gamma with a ready-to-go presentation outline and content, as this approach saves time by ensuring an effective and consistent theme throughout the presentation.²⁶ Gamma has 400 free credits to use at signup. After that, a monthly subscription of \$10 includes 400 credits a month and a monthly subscription of \$20 includes unlimited AI creation. A 12-month subscription saves 20 percent of the cost of the single-monthly plan.

VI. AI AND ETHICS FOR PH.D. STUDENTS

For Ph.D. students, understanding the ethical implications associated with AI is paramount. Firstly, it is essential for students to acknowledge that representing AI-generated text as their own work is strictly prohibited in academia. Academic dishonesty of this nature is unacceptable and can severely tarnish their reputation. To avoid any misunderstandings, students should clearly indicate in footnotes of any written work how they utilized AI. This includes if AI was used to generate outlines as a basis for the writing or if AI was employed for proofreading purposes. Such disclosure not only ensures transparency regarding the level of original thought in a work product but also aids in our understanding as a profession of how AI can be harnessed to enhance research productivity.

²⁶ Like Gamma, Prezo is a web-based tool for creating presentations, which has manual or multimodal AI options. The content is input through a document upload or a prompt, after which users select a desired aesthetic. As with Gamma, Ph.D. students may find mixed results when preparing academic research presentations with a multimodal AI tool. The strength of Prezo and Gamma lies in achieving a consistent aesthetic through the prompting and revision stages. On occasions where aesthetics are prioritized over content, these tools should suffice. However, our experience indicates that little time or effort is saved using AI for academic research presentations.

Secondly, utilizing AI tools can alleviate the workloads that Ph.D. students face. However, overly relying on AI as a shortcut to reduce workloads can have detrimental long-term consequences. For instance, by excessively depending on AI-generated summaries instead of reading papers and developing one's own summary, students may deprive themselves of the opportunity to develop a profound understanding of the literature and to acquire skills in critically evaluating arguments presented in research papers. It is imperative for students to recognize that adopting a responsible approach towards utilizing AI is crucial for their long-term success.

One potential approach for students is to employ AI as a supplementary tool rather than relying on it as a substitute for tasks that are fundamental to learning essential skills as a researcher (Dergaa et al. 2023). For instance, students can utilize AI-generated summaries to critically analyze their own comprehension of a research paper, instead of excessively depending on AI-generated summaries to replace the reading process. It is crucial that students employ AI in a manner that enhances their understanding of their field rather than diminishing their cognitive comprehension by taking shortcuts. Students should also keep in mind that they need to continuously scrutinize the impact of AI on the effectiveness of their learning and work.

When engaging with faculty mentors, it is crucial to exercise caution when relying heavily on AI-processed write-ups. Meetings between mentees and mentors that are based solely on AI-processed, nicely worded write-ups that lack deep intellectual engagement from the students are unlikely to result in productive outcomes. Without a thorough understanding of the ideas being presented, the foundation for substantive discussions is weakened. Ph.D. students need to recognize that ideas evolve and improve through active intellectual involvement, which is hindered when there is a lack of comprehension. Therefore, it is vital for students to refrain

from distributing to their mentor AI-processed, well-sounding output that has not been sufficiently thought through.

VII. INTEGRATING AI INTO PH.D. CURRICULA

AI has emerged as a vital resource for faculty members and Ph.D. students, significantly augmenting the efficacy of faculty mentorship. To fully leverage this potential, it is essential to integrate AI concepts and tools into introductory research courses designed for Ph.D. students. This integration involves, on one hand, a thorough discussion of AI, focusing on its capabilities but also including critical issues associated with the technology, such as data privacy, the potential for bias within AI algorithms, and the limitations and fallibility of the technology. On the other hand, it necessitates instruction on the effective and especially the responsible use of AI in Ph.D. training and research.

Given the ethical considerations surrounding AI, it is crucial for faculty to establish clear expectations for Ph.D. students regarding the use of AI-generated content from the beginning of their programs. In Ph.D. introductory seminars, it is important to establish boundaries for the use of AI. This is especially true when AI is used in a way that can potentially obscure a student's engagement in preparing for the seminar (Xu and Babaian 2021). When it comes to writing, it is also important for faculty to provide clear guidelines to ensure that students use AI in an ethical manner. Providing clear and consistent guidelines to Ph.D. students is necessary to be able to address any violations that may arise.

However, AI does not only present ethical challenges but also offers opportunities. By incorporating AI tools into the curriculum, Ph.D. students can be empowered to become more productive and independent researchers. We encourage faculty members to consider this potential when providing guidance to Ph.D. students on the appropriate use of AI. Faculty

members should also consider how the use of AI tools may assist them in more effectively managing their time in Ph.D. student mentoring.

Professional organizations, such as the American Accounting Association (AAA), should play a role in facilitating discussions on the integration of AI in Ph.D. program curricula.²⁷ This can be done by forming task forces and organizing panel sessions and workshops on this topic at conferences. Professional associations also have the potential to provide relevant information and training to faculty members on the latest technological advancements. By fulfilling this role, professional bodies contribute to ensuring a higher level of fairness and equity.

Academic institutions should support their departments in their efforts to incorporate AI into Ph.D. curricula. This can be done by establishing college and university-wide committees that evaluate the opportunities and risks associated with AI. It is of utmost importance for universities to deliberate on how they can effectively facilitate faculty development in this emerging technological landscape.

VIII. CONCLUSION

AI is an irreversible part of academia's future. In the high-pressure environment of accounting research training, AI will likely be used in various ways, with both positive and negative aspects. This article provides Ph.D. students with guidance on using AI to enhance their productivity responsibly. It also hopes to initiate a discussion within the community of established researchers about incorporating AI into accounting Ph.D. student curricula, aiming to improve training efficiency and the responsible use of AI.

²⁷ As a profession we have developed standards in how we conduct research. For instance, as accountants we most deeply frown upon the use of deception when dealing with participants in experimental research. AI poses a paradigm shift, and we need a conversation as a profession to develop new standards of conduct for this new AI driven world. The AAA as our professional organization can play a vital role by providing formats to have this conversation and develop these new standards.

The paper presents a thoughtfully selected array of AI tools to assist Ph.D. students in five key areas: 1) literature search and analysis, 2) statistical analysis, 3) data collection, 4) writing support, and 5) presenting findings. Each tool was evaluated based on functionality, learning curve, accessibility, and cost. Early adoption of these tools by Ph.D. students is emphasized, as many incorporate AI features that learn from user preferences, providing long-term efficiency and productivity benefits. We present in this paper in the five key areas a carefully curated selection of AI tools by providing a summary of capabilities and any associated costs of each tool. We provide as supplemental material online detailed instructional videos on each tool that allow a time efficient and easy introduction to these tools. Lastly, we provide considerations specifically targeted to Ph.D. students on the ethical use of AI as part of a well-considered research strategy. We also present a section for faculty mentors on the necessity to develop ethical boundaries for Ph.D. students for the use of AI.

This paper seeks to enhance equity among Ph.D. students at institutions of various sizes and financial means, while also serving as a resource for senior faculty involved in Ph.D. training and academic administrators. Senior faculty are provided with insights into AI's capabilities, offering a starting point for considering how this emerging technology could impact Ph.D. training. Academic administrators gain an overview of the current costs associated with AI tools, aiding in resource planning for Ph.D. students and faculty. The article also highlights the need for organizational changes to guide and shape the transformative process in higher education driven by AI.

AI does not just pose an iteration of an existing technology. It is a paradigm shift. Hence, incorporating AI into Ph.D. training is a necessity. Ph.D. programs are well advised to prepare their students for a future where AI is integral to research and professional practice. By

considering today how to incorporate AI in Ph.D. curricula, academic institutions can ensure their graduates are not only proficient in traditional accounting research methodologies but are also prepared for a tomorrow that will be transformed by AI. We hope our paper contributes to starting a discussion on how precisely our profession will incorporate AI in the training of the researchers in our field of tomorrow.

References

- Applebaum, D., H. Issa, M. Lenk, K. Moffitt, B. Muehlmann, and R. Nehmer. 2023. *ChatGPT and Accounting Education*. Hoboken, NJ: Wiley. <https://www.wiley.com/wp-content/uploads/2023/08/Wiley-SET-ChatGPT-and-Accounting-Education-Whitepaper-2023.pdf>
- AACSB. 2023. *2020 Guiding Principles and Standards for AACSB Business Accreditation*. <https://www.aacsb.edu/educators/accreditation/business-accreditation/aacsb-business-accreditation-standards>
- AACSB Thought Leadership. 2023. Business School Innovation in the Age of Generative AI. *Briefing*. (November 29). <https://www.aacsb.edu/insights/briefings/business-school-innovation-in-the-age-of-generative-ai>
- Athaluri, S. A., S. V. Manthena, V. S. R. K. M. Kesapragada, V. Yarlagadda, T. Dave, and R. T. S. Duddumpudi. 2023. Exploring the boundaries of reality: Investigating the phenomenon of artificial intelligence hallucination in scientific writing through ChatGPT references. *Cureus* 15(4):e37432. <https://doi.org/10.7759/cureus.37432>
- Beath, C., I. Becerra-Fernandez, J. Ross, and J. Short. 2012. Finding value in the information explosion. *MIT Sloan Management Review* 53 (4): 18. <https://sloanreview.mit.edu/article/finding-value-in-the-information-explosion/>
- Bello, C. 2023. The best AI tools to power your academic research. *Euronews.next* (December 11). <https://www.euronews.com/next/2023/11/12/best-ai-tools-academic-research-chatgpt-consensus-chatpdf-elicite-research-rabbit-scite>
- Cardilini, A. P. A., A. Risely, and M. F. Richardson. 2022. Supervising the PhD: Identifying common mismatches in expectations between candidate and supervisor to improve research training outcomes. *Higher Education Research & Development* 41 (3): 613–627. <https://doi.org/10.1080/07294360.2021.1874887>
- Chowdhary, K. R. 2020. Natural language processing. *Fundamentals of Artificial Intelligence*. 603–649. New Dehli, India: Springer. https://doi.org/10.1007/978-81-322-3972-7_19
- Consensus. 2022. How a Consensus search works & other FAQ's. *Consensus.app*. (April 3). <https://consensus.app/home/blog/welcome-to-consensus/>
- Dawkins, M. C. 2023. Declining enrollments—A call to action! *Issues in Accounting Education* 38 (1): 9–18. <https://doi.org/10.2308/ISSUES-2022-088>
- Dergaa, I., K. Chamari, P. Zmijewski, and H. Ben Saad. 2023. From human writing to artificial intelligence generated text: Examining the prospects and potential threats of ChatGPT in academic writing. *Biology of Sport* 40 (2): 615–622. <https://doi.org/10.5114/biol sport.2023.125623>
- Drapkin, A. 2023. Does ChatGPT save my data? OpenAI's privacy policy explained. *Tech.co* (June 29). <https://tech.co/news/does-chatgpt-save-my-data>
- Elasticsearch. 2023. What is vector search? *Elastic.co*. <https://www.elastic.co/what-is/vector-search>

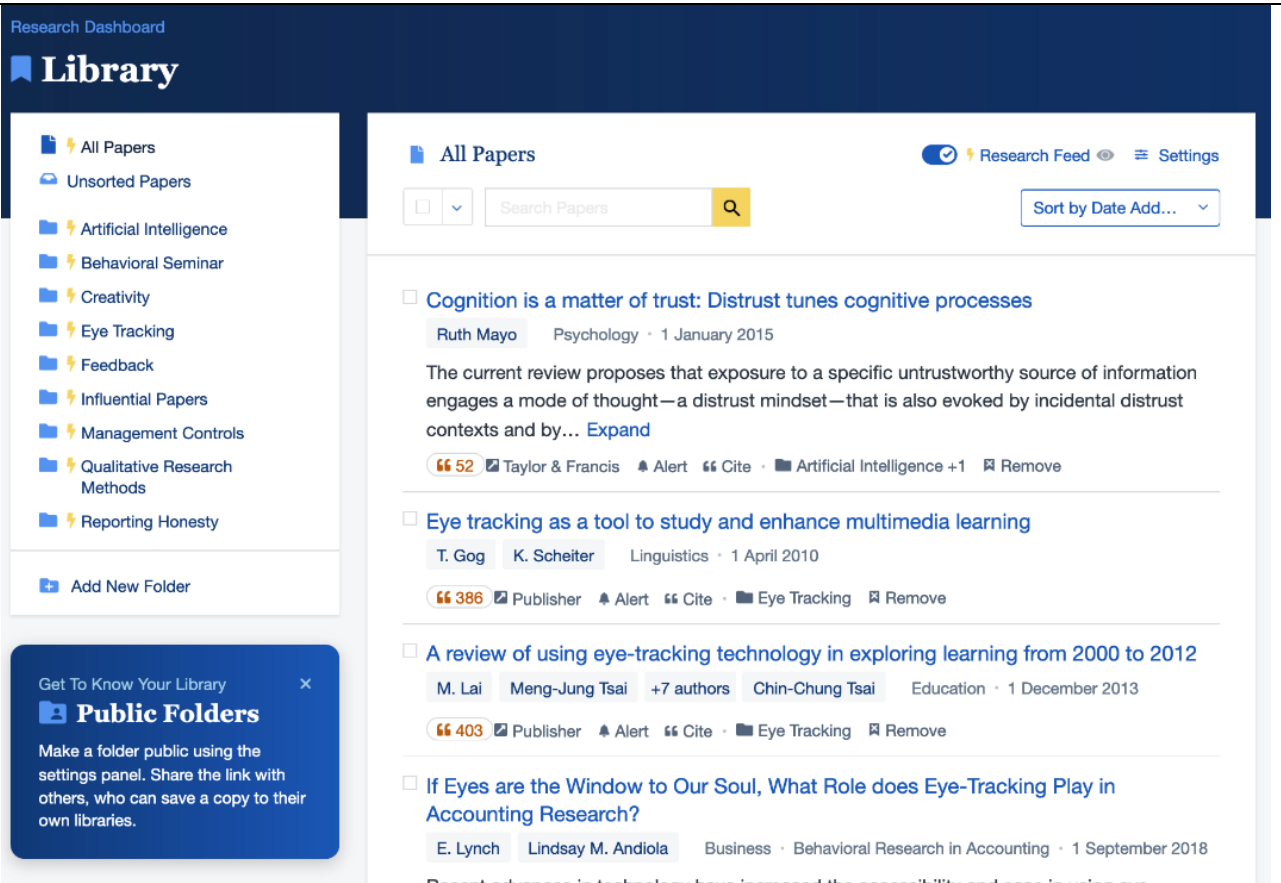
- Francavilla, M. L. 2018. Learning, teaching and writing with reference managers. *Pediatric Radiology* 48 (10): 1393–1398. <https://doi.org/10.1007/s00247-018-4175-z>
- Huang, J., and M. Tan. 2023. The role of ChatGPT in scientific communication: Writing better scientific review articles. *American Journal of Cancer Research* 13 (4): 1148–1154. <https://e-century.us/files/ajcr/13/4/ajcr0150104.pdf>
- IBL News. 2023. ChatGPT-4, the Fined Tuned Version of ChatGPT-3, Might Prompt a Major Shift. *IBL News*. (January 2). <https://iblnews.org/chatgpt-4-the-fined-tuned-version-of-chatgpt-3-might-prompt-a-major-shift/>
- Giray, L. 2023. Prompt engineering with ChatGPT: A guide for academic writers. *Annals of Biomedical Engineering* 51(12): 2629–2633. <https://doi.org/10.1007/s10439-023-03272-4>
- Jones, B. M. 2023. How generative AI tools help transform academic research. *Forbes*. (September 28). <https://www.forbes.com/sites/beatajones/2023/09/28/how-generative-ai-tools-help-transform-academic-research/?sh=675809cd34fc>
- Kim, J., K. Merrill, K. Xu, and D. D. Sellnow. 2020. My teacher is a machine: Understanding students’ perceptions of AI teaching assistants in online education. *International Journal of Human-Computer Interaction* 36 (20): 1902–1911. <https://doi.org/10.1080/10447318.2020.1801227>
- Kim, S. G. 2023. Using ChatGPT for language editing in scientific articles. *Maxillofacial Plastic and Reconstructive Surgery* 45 (13). <https://doi.org/10.1186/s40902-023-00381-x>
- Lingard, L. 2023. Writing with ChatGPT: An illustration of its capacity, limitations & implications for academic writers. *Perspectives on Medical Education* 12 (1): 261–270. <https://doi.org/10.5334/pme.1072>
- Lund, B. D., T. Wang, N. R. Mannuru, B. Nie, S. Shimray, and Z. Wang. 2023. ChatGPT and a new academic reality: Artificial Intelligence-written research papers and the ethics of the large language models in scholarly publishing. *Journal of the Association for Information Science and Technology* 74 (5): 570–581. <https://doi.org/10.1002/asi.24750>
- Mishra, C., and D. L. Gupta. 2017. Deep machine learning and neural networks: An overview. *IAES International Journal of Artificial Intelligence* 6 (2): 66–73. <http://doi.org/10.11591/ijai.v6.i2.pp66-73>
- MIT Technology Review Insights. 2021. Embracing the rapid pace of AI. *MIT Technology Review* (May 19). <https://www.technologyreview.com/2021/05/19/1025016/embracing-the-rapid-pace-of-ai/>
- News News. 2023. The speed of AI progress: A comparison with other technological advancements. *Medium.com* (September 25). <https://newnews123.medium.com/the-speed-of-ai-progress-a-comparison-with-other-technological-advancements-7efccf2a894b>
- O’Leary, D. E. 2022. Massive data language models and conversational artificial intelligence: Emerging issues. *Intelligent Systems in Accounting, Finance and Management* 29 (3): 182–198. <https://doi.org/10.1002/isaf.1522>
- O’Leary, D. E. 2023. An analysis of three chatbots: BlenderBot, ChatGPT and LaMDA. *Intelligent Systems in Accounting, Finance and Management* 30 (1): 41–54. <https://doi.org/10.1002/isaf.1531>

- OpenAI. 2023a. Our structure. <https://openai.com/our-structure>
- OpenAI. 2023b. ChatGPT (Nov 21 version) [Large language model]. <https://chat.openai.com/chat>
- Perkel, J. 2020. Streamline your writing—And collaborations—With these reference managers. *Nature*. (September 1). <https://www.nature.com/articles/d41586-020-02491-2>
- Polonioli, A. 2020. In search of better science: On the epistemic costs of systematic reviews and the need for a pluralistic stance to literature search. *Scientometrics* 122 (2): 1267–1274. <https://doi.org/10.1007/s11192-019-03333-3>
- Resume Builder. 2023. 1 in 4 companies have already replaced workers with ChatGPT. *ResumeBuilder.com* (February 27). <https://www.resumebuilder.com/1-in-4-companies-have-already-replaced-workers-with-chatgpt/>
- Reynolds, L., and K. McDonell. 2021. Prompt programming for Large Language Models: Beyond the few-shot paradigm. *arXiv* 2102.07350v1 [cs.CL]. <https://doi.org/10.48550/arXiv.2102.07350>
- Shevchuk, V. 2023. GPT-4 parameters explained: Everything you need to know. *Level-up Coding* (May 17). <https://levelup.gitconnected.com/gpt-4-parameters-explained-everything-you-need-to-know-e210c20576ca>
- Shoufan, A. 2023. Can students without prior knowledge use ChatGPT to answer test questions? An empirical study. *ACM Transactions on Computing Education*. <https://doi.org/10.1145/3628162>
- Stokel-Walker, C. 2023. ChatGPT listed as author on research papers: Many scientists disapprove. *Nature* 613 (7945): 620-621. <https://doi.org/10.1038/d41586-023-00107-z>. PMID: 36653617.
- Synopsys. 2023. What is AI Chip Design? *Synopsys.com*. <https://www.synopsys.com/ai/what-is-ai-chip-design.html#:~:text=AI%2Ddriven%20chip%20design%20involves,for%20chips%20is%20quite%20large.>
- van Dis, E. A. M., J. Bollen, W. Zuidema, R. van Rooij, and C. L. Bockting. 2023. ChatGPT: Five priorities for research. *Nature* 614: 224–226. <https://doi.org/10.1038/d41586-023-00288-7>
- Wei, J., X. Wang, D. Schuurmans, M. Bosma, B. Ichter, F. Xia, E. H. Chi, Q. V. Le, and D. Zhou. 2022. Chain-of-thought prompting elicits reasoning in large language models. *arXiv* 2201.11903 [cs.CL]. <https://doi.org/10.48550/arXiv.2201.11903>
- Wood, D. A., M. P. Achhpilia, M. T. Adams, S. Aghazadeh, K. Akinyele, M. Akpan, K. D. Allee, A. M. Allen, E. D. Almer, D. Ames, V. Arity, D. Barr-Pulliam, K. A. Basoglu, A. Belnap, J. W. Bentley, T. Berg, N. R. Berglund, E. Berry, A. Bhandari, ... E. Zoet. 2023. The ChatGPT artificial intelligence chatbot: How well does it answer accounting assessment questions? *Issues in Accounting Education* 38 (4): 81–108. <https://doi.org/10.2308/ISSUES-2023-013>

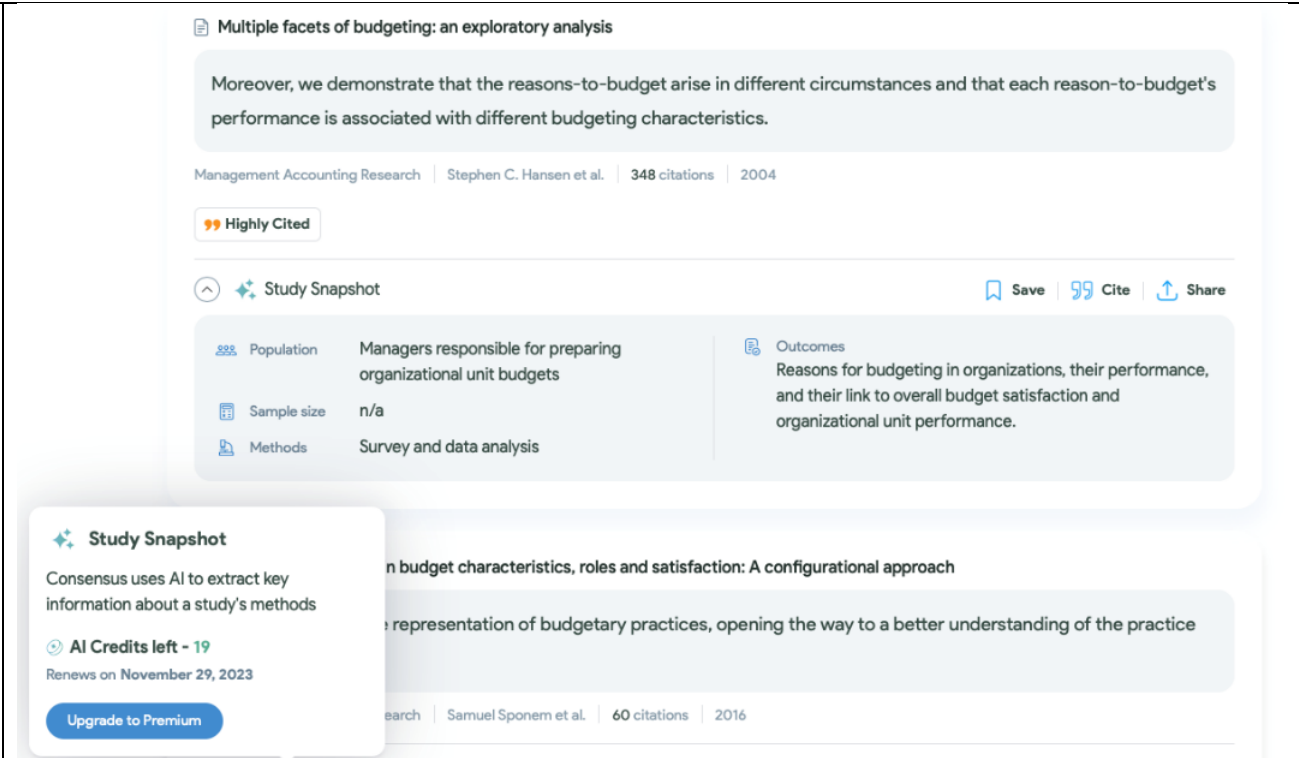
Xu, J. J., and T. Babaian. 2021. Artificial intelligence in business curriculum: The pedagogy and learning outcomes. *The International Journal of Management Education* 19 (3): 100550. <https://doi.org/10.1016/j.ijme.2021.100550>

Figure 1. Screenshots of AI Tools

Panel A: Literature Search and Summarization

Tool	Notes	Screenshot
<p>Semantic Scholar</p>	<p>The library organized and synchronized with Zotero.</p> <p>Each paper shows several influential citations from the results summary page.</p> <p>Set alerts for your research feed from library and search summaries.</p>	 <p>The screenshot displays the Semantic Scholar 'Library' interface. On the left, there is a sidebar with a 'Library' header and a list of folders including 'All Papers', 'Unsorted Papers', 'Artificial Intelligence', 'Behavioral Seminar', 'Creativity', 'Eye Tracking', 'Feedback', 'Influential Papers', 'Management Controls', 'Qualitative Research Methods', and 'Reporting Honesty'. Below the folders is an 'Add New Folder' button. A blue notification box titled 'Public Folders' is visible, stating: 'Get To Know Your Library Public Folders Make a folder public using the settings panel. Share the link with others, who can save a copy to their own libraries.' The main content area shows a list of papers under the heading 'All Papers'. The first paper is 'Cognition is a matter of trust: Distrust tunes cognitive processes' by Ruth Mayo, published in Psychology on 1 January 2015. The second paper is 'Eye tracking as a tool to study and enhance multimedia learning' by T. Gog and K. Scheiter, published in Linguistics on 1 April 2010. The third paper is 'A review of using eye-tracking technology in exploring learning from 2000 to 2012' by M. Lai, Meng-Jung Tsai, +7 authors, and Chin-Chung Tsai, published in Education on 1 December 2013. The fourth paper is 'If Eyes are the Window to Our Soul, What Role does Eye-Tracking Play in Accounting Research?' by E. Lynch and Lindsay M. Andiola, published in Business - Behavioral Research in Accounting on 1 September 2018.</p>

<p>Semantic Scholar</p>	<p>Citations are categorized in top right panel.</p> <p>Direct proxied library access with a single click.</p> <p>Citations, references, and related papers are accessible from the top of the page.</p>	<p>DOI: 10.1111/J.1475-679X.2008.00277.X • Corpus ID: 34315218</p> <h2>Measuring and Motivating Quantity, Creativity, or Both</h2> <p>Steven J. Kachelmeier, Bernhard Reichert, Michael G. Williamson • Published 1 May 2008 • Economics • Managerial Accounting</p> <p>ABSTRACT We examine how worker productivity differs when compensation is based on quantity, creativity, or the product of both measures. In an experiment in which participants design "rebus puzzles," we find that combining quantity and creativity measures in a creativity-weighted pay scheme results in creativity-weighted productivity scores that are significantly lower than those generated by participants with quantity incentives alone. Follow-up analysis indicates that relative to participants... Expand</p> <p>Access PDF via LibKey IPDF wwwdocs.fce.unsw.edu.au</p> <p>In Library Disable Alert Cite</p> <p>163 Citations 36 References Related Papers</p> <p>163 Citations</p> <p>Search authors, publications, <input type="text"/> Date Range <input type="text"/> Citation Type <input type="text"/> Has PDF <input type="text"/> Author <input type="text"/> More Filters <input type="text"/> Sort by Relevance <input type="text"/></p> <p>How is creativity measured in behavioral accounting research?</p> <p><input type="checkbox"/> Synthesize <input type="text"/> Filter <input type="text"/> Save search <input type="text"/> Share</p> <p>beta These features are in Beta and not 100% accurate. You can share feedback here</p> <p>Summary <input type="text"/> Top 3 papers analyzed</p> <p>These studies suggest that creativity is measured in behavioral accounting research through methods such as categorizing behaviors, using self-report scales like Scab, and assessing novel behavioral sequences in animals.</p> <p>Consensus Meter <input type="text"/> Not a "Yes or No" question. To use the Consensus Meter, try asking a simple Yes/No question.</p> <p>e.g. Does beta alanine improve exercise performance?</p> <p>163 Citations</p> <ul style="list-style-type: none"> Highly Influential Citations 17 Background Citations 68 Methods Citations 11 Results Citations 13 <p>View All</p>
<p>Consensus</p>	<p>Search results are summarized and assigned a metric for support.</p>	This content is now part of the screenshot above and is not repeated here

<p>Consensus</p>	<p>Search result tiles summarize key elements of a study in the Study Snapshot.</p> <p>Study Snapshots require the use of credits for access.</p>	 <p>The screenshot shows a search result tile for a study titled "Multiple facets of budgeting: an exploratory analysis" by Stephen C. Hansen et al. (2004). The tile includes a summary of the study's findings, a "Highly Cited" badge, and a "Study Snapshot" section. The "Study Snapshot" section provides key information about the study's methods, population, and outcomes. A pop-up window in the foreground explains that Consensus uses AI to extract key information about a study's methods and that the user has 19 AI credits left, which renew on November 29, 2023. There is a button to "Upgrade to Premium".</p> <p>Multiple facets of budgeting: an exploratory analysis</p> <p>Moreover, we demonstrate that the reasons-to-budget arise in different circumstances and that each reason-to-budget's performance is associated with different budgeting characteristics.</p> <p>Management Accounting Research Stephen C. Hansen et al. 348 citations 2004</p> <p>Highly Cited</p> <p>Study Snapshot</p> <p>Save Cite Share</p> <table border="1"> <tr> <td>Population</td> <td>Managers responsible for preparing organizational unit budgets</td> <td>Outcomes</td> <td>Reasons for budgeting in organizations, their performance, and their link to overall budget satisfaction and organizational unit performance.</td> </tr> <tr> <td>Sample size</td> <td>n/a</td> <td></td> <td></td> </tr> <tr> <td>Methods</td> <td>Survey and data analysis</td> <td></td> <td></td> </tr> </table> <p>Study Snapshot</p> <p>Consensus uses AI to extract key information about a study's methods</p> <p>AI Credits left - 19</p> <p>Renews on November 29, 2023</p> <p>Upgrade to Premium</p> <p>...n budget characteristics, roles and satisfaction: A configurational approach</p> <p>...representation of budgetary practices, opening the way to a better understanding of the practice</p> <p>...earch Samuel Sponem et al. 60 citations 2016</p>	Population	Managers responsible for preparing organizational unit budgets	Outcomes	Reasons for budgeting in organizations, their performance, and their link to overall budget satisfaction and organizational unit performance.	Sample size	n/a			Methods	Survey and data analysis		
Population	Managers responsible for preparing organizational unit budgets	Outcomes	Reasons for budgeting in organizations, their performance, and their link to overall budget satisfaction and organizational unit performance.											
Sample size	n/a													
Methods	Survey and data analysis													

SciSpace

Document text is shown adjacent to the co-pilot panel for quick access.

Home / My Library / Behavioral Seminar / Rose et al (2022) BRI(A) Uncertainty Visualization.pdf

Explain math & table 100%

BEHAVIORAL RESEARCH IN ACCOUNTING
Vol. 34, No. 1
Spring 2022
pp. 113-139

American Accounting Association
DOI: 10.2310/BRIA-2021-011

Effects of Uncertainty Visualization on Attention, Arousal, and Judgment

Anna M. Rose
University of Northern Colorado

Jacob M. Rose
University of Northern Colorado
Monash University

Kristian Rotaru
Monash University

Kerri-Ann Sanderson
Jay C. Thibodeau
Bentley University

ABSTRACT: Two experiments examine the effects of visualizing uncertainty on attention, cognitive arousal, and incorporation of uncertainty information into judgments. The first experiment employs psychophysiological measurements to understand how different presentations of uncertainty information influence decision-making processes. Results indicate that participants attend more to uncertainty information when uncertainty is incorporated directly into a visualization. Pupillometry and eye-tracking analyses indicate that participants exhibit greater attention to uncertainty information, fixate more on the bounds of uncertainty, and spend more time examining uncertainty information when uncertainty is visualized, compared to when uncertainty is depicted textually (i.e., not visually). In addition, the decisions of participants who view visualizations directly depicting uncertainty better integrate the level of uncertainty in the underlying data. The second experiment reveals that experienced auditors are more likely to appropriately use uncertainty information when it is visualized.

Keywords: audit quality, eye tracking, judgment, uncertainty, visualization.

1. INTRODUCTION

Emerging data sources and new techniques for analyzing and visualizing complex data sets are changing the nature of decision-making across many professional domains. For example, financial statement auditors are beginning to evaluate Big Data as sources of audit evidence and to employ sophisticated cognitive technologies to evaluate these new data sources (Appelbaum, Kogan, and Vasarhelyi 2017). Use of new data sources and technologies offers significant opportunities to improve audit quality (A. Rose, J. Rose, Rotaru, Sanderson, and Thibodeau 2021; A. Rose, J. Rose, Sanderson, and Thibodeau 2017; Brown-Libard, Iva, and Lombardi 2015). However, emerging data sources are rife with measurement

The authors thank our reviewers, editors, and workshop participants at Bentley University, Miami University, Monash University, and the University of Central Florida for their helpful comments and suggestions.

Anna M. Rose, University of Northern Colorado, Monahan College of Business, Department of Accounting and CIS, Greeley, CO, USA; Jacob M. Rose, University of Northern Colorado, Monahan College of Business, Department of Accounting and CIS, Greeley, CO, USA; Monash University, Monash Business School, Department of Accounting, Melbourne, Australia; Kristian Rotaru, Monash University, Monash Business School, Department of

Copilot Notes English (en)

Basic Premium

development. The sources primarily focus on the effects of visualizing uncertainty on attention, arousal, and judgment in decision-making. ...Read more

Write a feedback 9 Oct 2023

Save as note Follow up

The theory used in this paper is uncertainty visualization theory. The paper investigates how visualizing uncertainty affects decision-making processes and judgments. It extends previous research on uncertainty. Results of the paper 9 Oct 2023

Results of the paper:

- The first experiment found that participants paid more attention to uncertainty information when it was incorporated directly into a visualization, compared to when it was depicted textually. Puj ...Read more

Write a feedback 9 Oct 2023

2 Sources

Save as note Follow up

do they consider scan path? 10 Oct 2023

The provided sources do not specifically mention the consideration of scan path in the experiments conducted. The focus of the experiments was on the effects of visualizing uncertainty on attention, arousal, and judgment, rather than analyzing scan paths. The sources primarily discuss the participants' attention to uncertainty information, fixation on the bounds of uncertainty, and the integration of uncertainty information into judgments when uncertainty is visualized. The experiments utilized psychophysiological measurements such as pupillometry and eye tracking to understand participants' responses to different presentations of uncertainty information.

SciSpace

Annotations and notes are presented side-by-side for quick reference. Notes and highlights can be color coded and filtered and sorted accordingly.

Explain math & table 130%

psychology and computer science demonstrates that these visualizations are ineffective at communicating the margins of error associated with imprecise data (e.g., Correll and Gleicher 2014; Tak, Toet, and van Erp 2014; Newman and Scholl 2012; Sanyal et al. 2009; Behr, Fidler, Williams and Cumming 2005). These traditional visualization techniques are believed to be ineffective for two primary reasons. First, traditional visualizations such as column charts present highly salient graphical information, and users are assumed to believe that the column chart represents complete information. That is, users of these visualizations may perceive that all possible values are represented within the chart; additional information such as textual descriptions of margins of error or error bars do not overcome the visual salience of the graphic (Newman and Scholl 2012). Second, traditional visualizations could focus attention on point estimates and upper bounds, rather than ranges of possibility (van der Laan et al. 2015). Such a focus on point estimates would result in an inattention to ranges of error (i.e., uncertainty). Thus, while research concludes that decision makers generally understand visual presentations of uncertainty better than textual presentation of uncertainty (Lipkus and Hollands 1999), visual design is critical to successful use of the visualizations. In addition, the reasons for differences between column charts and other presentations are largely based on unstated assumptions about users' attentional focus. Overall, investigations of effective techniques for displaying uncertainty information suggest that there are opportunities to improve judgments by designing visualizations that better incorporate uncertainty information.

One alternate visualization technique that more actively incorporates uncertainty information into the visualization involves the creation of gradient plots. Gradient plots use variations in color and opacity to display more and less certainty, such that less intense colors and less opacity represent less certainty (see Appendix A for an example and Appendix B for a discussion of gradient plots). Decreasing color intensity and opacity are believed to create visual metaphors of certainty that non-experts in statistical inference can more easily understand and interpret (MacEachern, Roth, O'Brien, Li, Swingley, and Gahegan 2012; Jackson 2008; Gershon 1998), but rigorous empirical testing of these assumptions is limited. Correll and Gleicher (2014) find that gradient plots are more effective than column charts, or box and whisker plots, for improving user ability to recognize whether a single data point presented on a graph is more or less likely to occur than the mean. This finding suggests potential design benefits of gradient plots. In addition, they find that box and whisker plots are less effective than column charts with textual descriptions of margins of error. Overall, informed by research results, visualization design appears critical to effectively displaying uncertainty information.

Behavioral Research in Accounting
Volume 34, Number 1, 2022

116 Error, Error, Retain, Satisfaction, and Disbelief

Given the promise of enhanced visualization techniques to more effectively represent uncertainty information to users, we investigate the potential for visualizations that incorporate uncertainty to improve auditor judgment. Importantly, we delve deeper than existing research into users' root psychophysiological responses to different visualization techniques in order to better understand how and why visualization design features affect judgment and how new visualization techniques could enhance audit quality.

Psychophysiological Responses to Visualizations of Uncertainty

Attention and arousal are two psychophysiological responses that are particularly relevant to understanding the potential effects of enhanced visualizations that incorporate uncertainty and more traditional visualizations on judgment quality. Given the research evidence that auditors can fail to attend to: (1) important patterns revealed by visualizations, and (2) important disconfirming evidence, it is important to determine whether and how different visualization techniques influence attention to uncertainty information. Measuring attention to uncertainty information can reveal whether different visualization techniques can change decision makers' consideration of uncertainty information.

Arousal is defined as a change in a person's "physiological and/or psychological responsiveness to internal or external stimuli" (Howells, Suen, and Russell 2010, 39). Arousal is important because arousal levels significantly affect individuals' responses to stimuli, intensity of attention, and effort intensity (Meitner and Oh 2019; Howells et al. 2010; Kahneman 1973). Without arousal, effort is not directed toward understanding and interpreting external stimuli (Mathôt and van der Stigchel 2015; Sirois and Brisson 2014; Howells et al. 2010; Aston-Jones and Cohen 2005; Kahneman 1973). Thus, arousal captures multiple dimensions of the effects of visual stimuli on decision makers. Arousal predicts the amount of effort, the intensity of effort, and the intensity of attention that is devoted to processing a stimulus. The two main forms of arousal are cognitive arousal and emotional arousal.

Studies of uncertainty visualization suggest that traditional methods that supplementally describe uncertainty in text cause users to assume that a graphic represents all possible outcomes, and other information is largely ignored (Newman and Scholl 2012). As a result, traditional displays reduce attention to uncertainty information, while enhanced visualizations that incorporate uncertainty information can increase attention and arousal. However, these are unstated assumptions. Research has not examined the root psychophysiological responses of the proposed effects of different visualizations of uncertainty on decision makers' perceptions and judgments. We address this issue and propose that visualization techniques that incorporate uncertainty information will increase levels of attention, and arousal in response, to uncertainty information.

Copilot Notes

Search 20 results... Add Note

Filter by: ● ● ● ●

Benjamin Chapin · 7 Oct 2023

The firm also discovered that visualizing uncertainty helped in addressing issues associated with the COVID-19 pandemic, and new visualizations incorporate read more

Implications for practice.

7 Oct 2023

Benjamin Chapin · 7 Oct 2023

Thus, the high complexity of our case could increase the effects of visualizations on judgment quality relative to less complex decision contexts.

Instrument complexity is a limitation.

7 Oct 2023

Benjamin Chapin · 7 Oct 2023

We also limit the potential for increased cognitive load associated with the gradient plot relative to the column chart, to be a primary cause of the results.

What does this mean? Attention and cognitive load can be related, but in this case, a lack of cognitive load is also what drives inattention to uncertainty.

7 Oct 2023

Benjamin Chapin · 7 Oct 2023

Absolute's management estimates that there is a 90 percent chance of achieving an employee turnover rate below 5 percent, and it records the entire \$4 million read more

The AI system estimate is more conservative - a 15% error would result in a disproportionately sized error. Does this affect the manipulation?

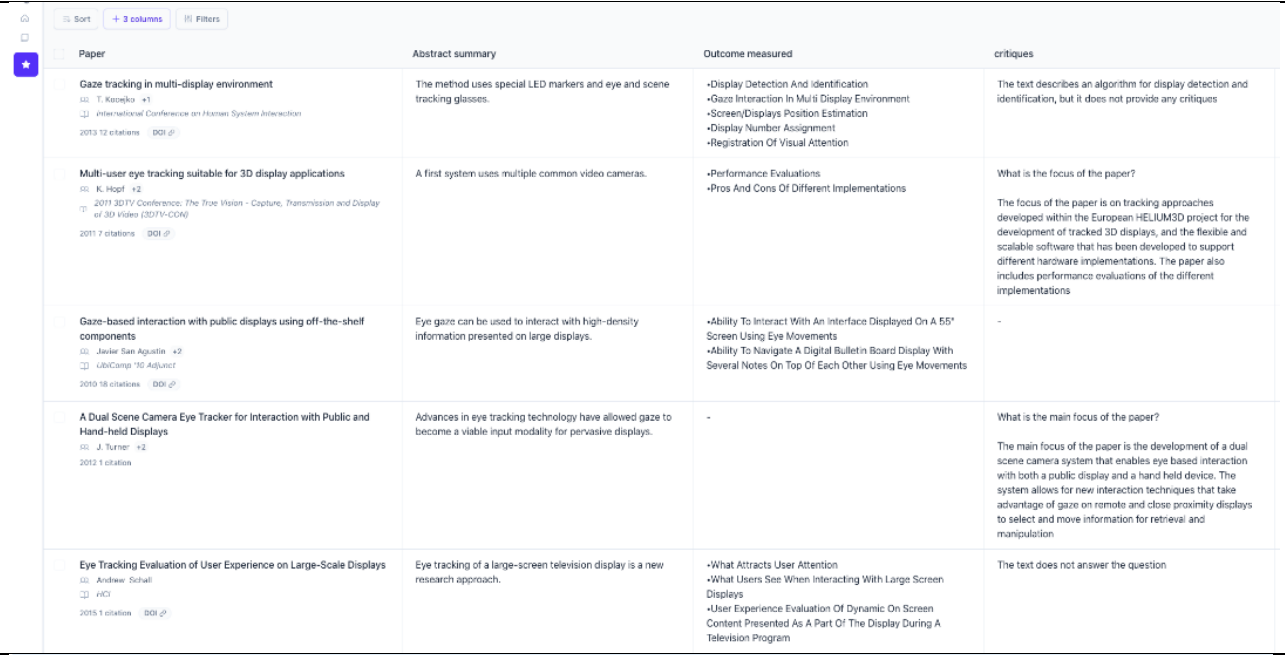
7 Oct 2023





Benjamin Chapin · 7 Oct 2023

The contrast is significant ($p < 0.016$), supporting H3. Buckless and Revenscroft (1990) and Guggenmos et al. (2018) argue that planned contrasts should read more



Benjamin Chapin · 7 Oct 2023

single contrast that examines whether perceived revenue overstatement is lower

<p>Elicit</p>	<p>Search results are presented in a tabular form for literature review.</p>	 <table border="1"> <thead> <tr> <th>Paper</th> <th>Abstract summary</th> <th>Outcome measured</th> <th>critiques</th> </tr> </thead> <tbody> <tr> <td>Gaze tracking in multi-display environment by T. Kuroko International Conference on Human System Interaction 2013 12 citations</td> <td>The method uses special LED markers and eye and scene tracking glasses.</td> <td> <ul style="list-style-type: none"> -Display Detection And Identification -Gaze Interaction In Multi Display Environment -Screens/Displays Position Estimation -Display Number Assignment -Registration Of Visual Attention </td> <td>The text describes an algorithm for display detection and identification, but it does not provide any critiques</td> </tr> <tr> <td>Multi-user eye tracking suitable for 3D display applications by K. Hopf 2011 3DTV Conference: The True Vision - Capture, Transmission and Display of 3D Video (3DTV-CODP) 2011 7 citations</td> <td>A first system uses multiple common video cameras.</td> <td> <ul style="list-style-type: none"> -Performance Evaluations -Pros And Cons Of Different Implementations </td> <td> <p>What is the focus of the paper?</p> <p>The focus of the paper is on tracking approaches developed within the European HELIUM3D project for the development of tracked 3D displays, and the flexible and scalable software that has been developed to support different hardware implementations. The paper also includes performance evaluations of the different implementations</p> </td> </tr> <tr> <td>Gaze-based interaction with public displays using off-the-shelf components by Javier San Agustín UBiCamp '15 Adjunct 2010 18 citations</td> <td>Eye gaze can be used to interact with high-density information presented on large displays.</td> <td> <ul style="list-style-type: none"> -Ability To Interact With An Interface Displayed On A 55" Screen Using Eye Movements -Ability To Navigate A Digital Bulletin Board Display With Several Notes On Top Of Each Other Using Eye Movements </td> <td>-</td> </tr> <tr> <td>A Dual Scene Camera Eye Tracker for Interaction with Public and Hand-held Displays by J. Turner 2012 1 citation</td> <td>Advances in eye tracking technology have allowed gaze to become a viable input modality for pervasive displays.</td> <td>-</td> <td> <p>What is the main focus of the paper?</p> <p>The main focus of the paper is the development of a dual scene camera system that enables eye based interaction with both a public display and a hand held device. The system allows for new interaction techniques that take advantage of gaze on remote and close proximity displays to select and move information for retrieval and manipulation</p> </td> </tr> <tr> <td>Eye Tracking Evaluation of User Experience on Large-Scale Displays by Andrew Schall HCI 2015 1 citation</td> <td>Eye tracking of a large-screen television display is a new research approach.</td> <td> <ul style="list-style-type: none"> -What Attracts User Attention -What Users See When Interacting With Large Screen Displays -User Experience Evaluation Of Dynamic On Screen Content Presented As A Part Of The Display During A Television Program </td> <td>The text does not answer the question</td> </tr> </tbody> </table>	Paper	Abstract summary	Outcome measured	critiques	Gaze tracking in multi-display environment by T. Kuroko International Conference on Human System Interaction 2013 12 citations	The method uses special LED markers and eye and scene tracking glasses.	<ul style="list-style-type: none"> -Display Detection And Identification -Gaze Interaction In Multi Display Environment -Screens/Displays Position Estimation -Display Number Assignment -Registration Of Visual Attention 	The text describes an algorithm for display detection and identification, but it does not provide any critiques	Multi-user eye tracking suitable for 3D display applications by K. Hopf 2011 3DTV Conference: The True Vision - Capture, Transmission and Display of 3D Video (3DTV-CODP) 2011 7 citations	A first system uses multiple common video cameras.	<ul style="list-style-type: none"> -Performance Evaluations -Pros And Cons Of Different Implementations 	<p>What is the focus of the paper?</p> <p>The focus of the paper is on tracking approaches developed within the European HELIUM3D project for the development of tracked 3D displays, and the flexible and scalable software that has been developed to support different hardware implementations. The paper also includes performance evaluations of the different implementations</p>	Gaze-based interaction with public displays using off-the-shelf components by Javier San Agustín UBiCamp '15 Adjunct 2010 18 citations	Eye gaze can be used to interact with high-density information presented on large displays.	<ul style="list-style-type: none"> -Ability To Interact With An Interface Displayed On A 55" Screen Using Eye Movements -Ability To Navigate A Digital Bulletin Board Display With Several Notes On Top Of Each Other Using Eye Movements 	-	A Dual Scene Camera Eye Tracker for Interaction with Public and Hand-held Displays by J. Turner 2012 1 citation	Advances in eye tracking technology have allowed gaze to become a viable input modality for pervasive displays.	-	<p>What is the main focus of the paper?</p> <p>The main focus of the paper is the development of a dual scene camera system that enables eye based interaction with both a public display and a hand held device. The system allows for new interaction techniques that take advantage of gaze on remote and close proximity displays to select and move information for retrieval and manipulation</p>	Eye Tracking Evaluation of User Experience on Large-Scale Displays by Andrew Schall HCI 2015 1 citation	Eye tracking of a large-screen television display is a new research approach.	<ul style="list-style-type: none"> -What Attracts User Attention -What Users See When Interacting With Large Screen Displays -User Experience Evaluation Of Dynamic On Screen Content Presented As A Part Of The Display During A Television Program 	The text does not answer the question
Paper	Abstract summary	Outcome measured	critiques																							
Gaze tracking in multi-display environment by T. Kuroko International Conference on Human System Interaction 2013 12 citations	The method uses special LED markers and eye and scene tracking glasses.	<ul style="list-style-type: none"> -Display Detection And Identification -Gaze Interaction In Multi Display Environment -Screens/Displays Position Estimation -Display Number Assignment -Registration Of Visual Attention 	The text describes an algorithm for display detection and identification, but it does not provide any critiques																							
Multi-user eye tracking suitable for 3D display applications by K. Hopf 2011 3DTV Conference: The True Vision - Capture, Transmission and Display of 3D Video (3DTV-CODP) 2011 7 citations	A first system uses multiple common video cameras.	<ul style="list-style-type: none"> -Performance Evaluations -Pros And Cons Of Different Implementations 	<p>What is the focus of the paper?</p> <p>The focus of the paper is on tracking approaches developed within the European HELIUM3D project for the development of tracked 3D displays, and the flexible and scalable software that has been developed to support different hardware implementations. The paper also includes performance evaluations of the different implementations</p>																							
Gaze-based interaction with public displays using off-the-shelf components by Javier San Agustín UBiCamp '15 Adjunct 2010 18 citations	Eye gaze can be used to interact with high-density information presented on large displays.	<ul style="list-style-type: none"> -Ability To Interact With An Interface Displayed On A 55" Screen Using Eye Movements -Ability To Navigate A Digital Bulletin Board Display With Several Notes On Top Of Each Other Using Eye Movements 	-																							
A Dual Scene Camera Eye Tracker for Interaction with Public and Hand-held Displays by J. Turner 2012 1 citation	Advances in eye tracking technology have allowed gaze to become a viable input modality for pervasive displays.	-	<p>What is the main focus of the paper?</p> <p>The main focus of the paper is the development of a dual scene camera system that enables eye based interaction with both a public display and a hand held device. The system allows for new interaction techniques that take advantage of gaze on remote and close proximity displays to select and move information for retrieval and manipulation</p>																							
Eye Tracking Evaluation of User Experience on Large-Scale Displays by Andrew Schall HCI 2015 1 citation	Eye tracking of a large-screen television display is a new research approach.	<ul style="list-style-type: none"> -What Attracts User Attention -What Users See When Interacting With Large Screen Displays -User Experience Evaluation Of Dynamic On Screen Content Presented As A Part Of The Display During A Television Program 	The text does not answer the question																							
<p>Scite</p>	<p>The Scite assistant can address specific research questions and summarize references to support its results.</p>	 <p>We couldn't properly fact-check and verify our response. The below is the raw draft before our verification step, so it might have issues. Please use it at your own risk.</p> <p>Validated measures of creativity in behavioral accounting research can be assessed through various approaches (Kachelmeier et al., 2008), emphasized the subjective nature of creativity measures but highlighted the potential for investigating creativity within a management accounting framework (Kachelmeier et al., 2008). Furthermore, Porter et al. (2020) discussed the use of measures of creative process behaviors in evaluating creative performance, indicating the combination of evaluations of creative process behaviors with characteristics or outcomes outside the scope of creative process behavior (Porter et al., 2020). Additionally, Klein & Speckbacher (2019) highlighted the role of leadership behavior in evaluating the performance of creative teams based on customer-related accounting data, which can clarify the expected kind of creativity from the team and potentially enhance the creative process effectiveness (Klein & Speckbacher, 2019).</p> <p>Moreover, Conner et al. (2016) emphasized the significance of everyday creative activity in cultivating positive psychological functioning, which could be relevant in behavioral accounting research (Conner et al., 2016; Pin et al., 2022), also discussed different measures of creativity, including self-assessment measures of rating everyday creativity, which could be considered in behavioral accounting research (Pin et al., 2022). (2015) utilized behaviorally operationalized linguistic creativity measures, indicating the potential for similar operationalized measures in the context of accounting research (Rački et al., 2015).</p> <p>However, it is essential to note that the subjective nature of creativity measures and the controversy surrounding the effects of performance-based incentives on creativity, as discussed by Kachelmeier et al. (2018) and (Speckbacher, 2021), highlight the complexity of evaluating creativity in the context of behavioral accounting research (Kachelmeier et al., 2018; Speckbacher, 2021). Additionally, Bonetto & Arciszewski (2023) emphasized the importance of direct methods for investigating creative behavior, suggesting a need for specific and behaviorally operationalized measures in creativity research (Bonetto & Arciszewski, 2023).</p> <p>In conclusion, validated measures of creativity in behavioral accounting research can encompass a range of approaches, including the evaluation of creative process behaviors, leadership behavior in creative teams, and the significance of everyday creative activity. However, the subjective nature of creativity measures and the need for direct and behaviorally operationalized measures underscore the complexity of assessing creativity in the context of accounting research.</p> <p>View searches run to ground this response</p> <p>Not what you were looking for? Change Assistant Settings</p>																								

<p>Scite</p>	<p>References are summarized individually with context from the source.</p>	<p>Reference #1</p> <p>“...Although softer measures such as creativity are inherently subjective, there is no conceptual reason why they cannot also be investigated within a management accounting framework, as we attempt to illustrate in the current study...”</p> <p>▼ See full context</p> <p>Section: Implications Limitations and Future Directions</p> <p>Measuring and Motivating Quantity, Creativity, or Both</p> <p>Steven J. Kachelmeier¹, B. Reichert², Michael G. Williamson³ 2008</p> <p><i>J of Accounting Research</i></p> <p>  136  5  83  0 </p> <p> View full text Add to dashboard Cite </p>
--------------	---	---

Panel B: Data Collection

ChatGPT	Broad prompts can help the Ph.D. student to access factor analysis functionality in SPSS.	<p> You How can I perform a factor analysis to identify latent factors in my dataset using SPSS?</p> <p> ChatGPT Factor analysis is a statistical technique used to identify latent (unobservable) factors that underlie the observed variables in your dataset. These factors are often used to explain the patterns of correlation among variables. Here's a step-by-step guide on how to perform a factor analysis using IBM SPSS:</p> <ol style="list-style-type: none">1. Data Preparation:<ul style="list-style-type: none">• Load your dataset into SPSS.2. Data Screening:<ul style="list-style-type: none">• Before conducting factor analysis, it's essential to check your data for missing values, outliers, and appropriateness for factor analysis. You may want to remove or impute missing values and address outliers if necessary.3. Factor Analysis Setup:<ul style="list-style-type: none">• Click on "Analyze" in the SPSS menu.• Choose "Dimension Reduction" and then "Factor."4. Select Variables:<ul style="list-style-type: none">• In the "Factor" dialog box, select the variables you want to include in the factor analysis. You can move them from the left to the right box using the arrow buttons.5. Extraction Method:<ul style="list-style-type: none">• In the "Extraction" tab, you need to select the extraction method, which determines how the factors are initially extracted from the data. The most commonly used methods are:<ul style="list-style-type: none">• Principal Component Analysis (PCA): This method extracts factors based on the total variance in the data.• Principal Axis Factoring (PAF): This method extracts factors based on the common
---------	---	---

ChatGPT

Broad prompts can request basic programming support for a Ph.D. student trying to import their first dataset into SAS.

You
how do I import excel tables into sas?

ChatGPT
To import Excel tables into SAS (Statistical Analysis System), you can use the "IMPORT" procedure or the "DATA" step. Here's a step-by-step guide on how to do this:

1. Prepare Your Excel File:

- Ensure your Excel file is well-structured with a clear header row.
- Save or store your Excel file in a location accessible to your SAS environment.

2. Open SAS:

- Launch SAS and open a new program or project.

3. Using the IMPORT Procedure:

You can use the 'PROC IMPORT' procedure to import data from an Excel file. Here's an example of how to do it:

```
sas Copy code  
  
PROC IMPORT DATAFILE='your_excel_file.xlsx'  
  OUT=your_sas_dataset  
  DBMS=XLSX REPLACE;  
  GETNAMES=YES;  
RUN;
```

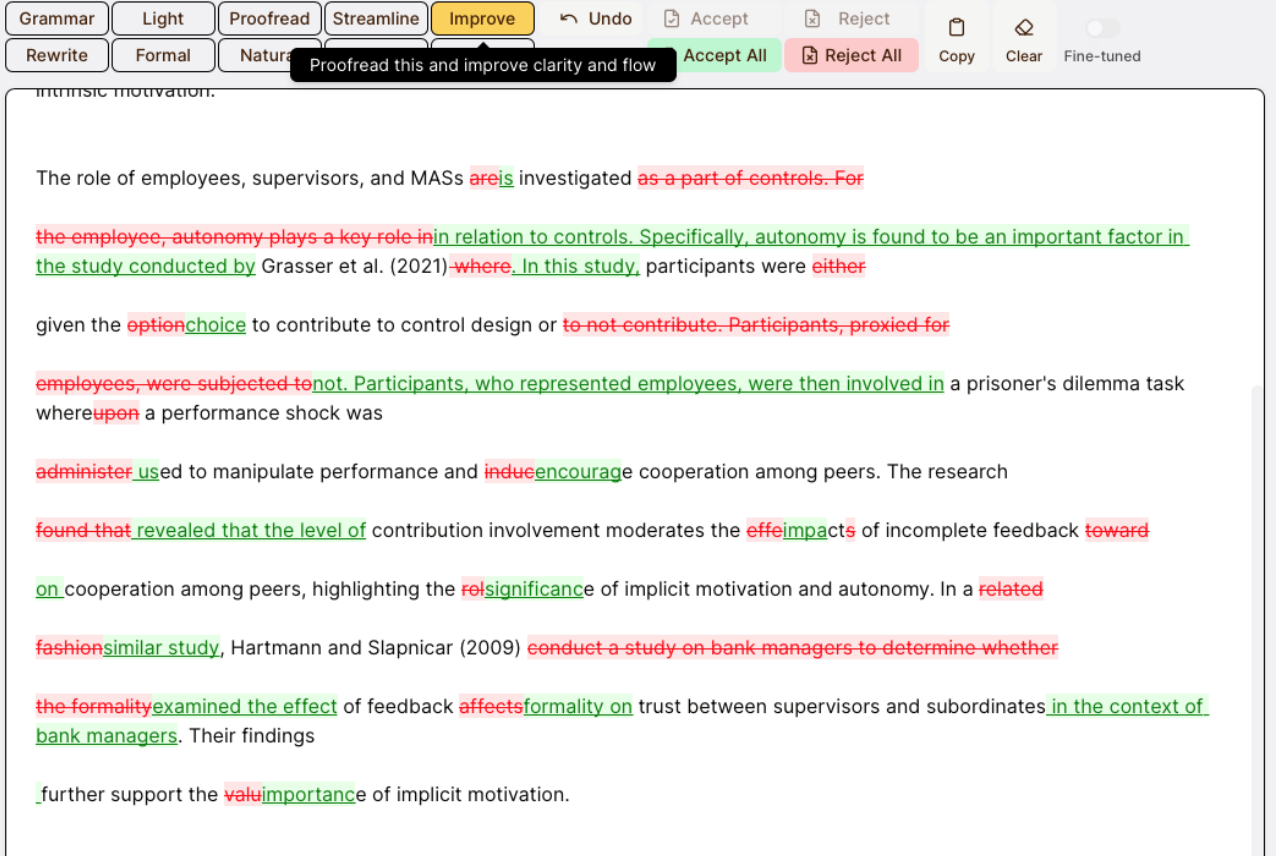
- 'DATAFILE': Specify the path to your Excel file.
- 'OUT': Define the name of the SAS dataset where the imported data will be stored.
- 'DBMS': Set it to XLSX for Excel files.
- 'REPLACE': This option allows you to replace the dataset if it already exists.
- 'GETNAMES': Specify whether the first row of the Excel file contains variable names.

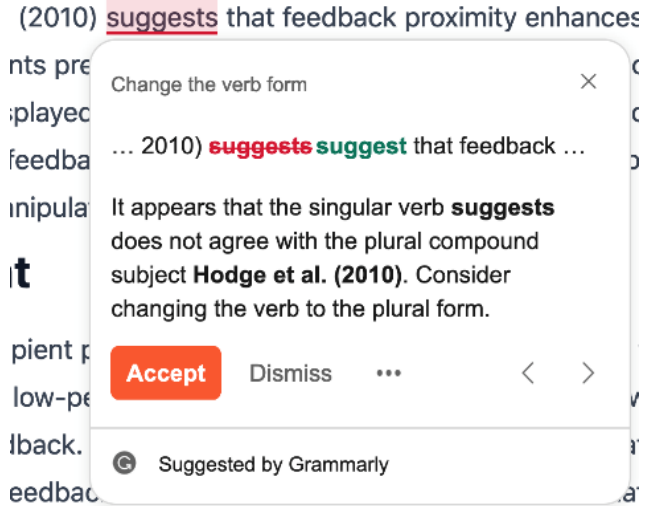
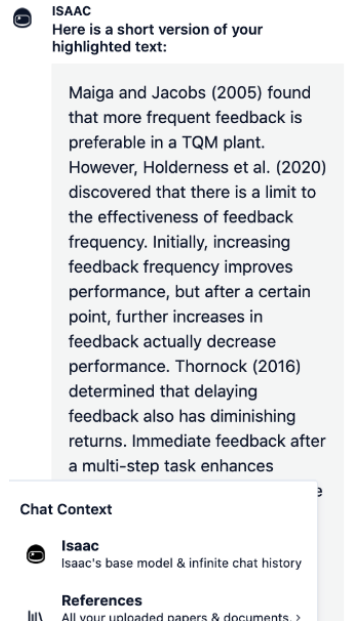
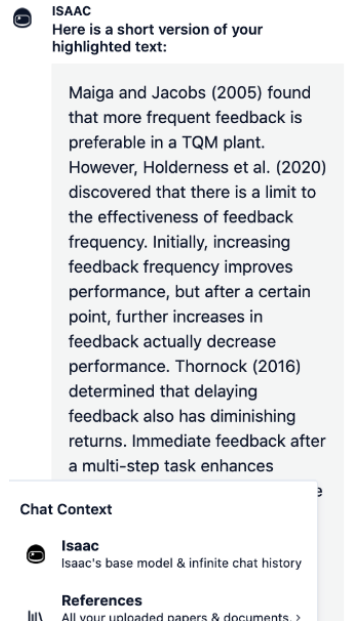
4. Using the DATA Step:

Alternatively, you can use a DATA step to import Excel data:

```
sas Copy code  
  
DATA your_sas_dataset;  
  INFILE 'your_excel_file.xlsx'
```

Panel C: Writing Support

<p>editGPT</p>	<p>Selected text can be edited for grammar, only or edited for concision and clarity by varied extent. Light is the least extensive and improve is the most extensive.</p> <p>Changes can be accepted or rejected individually or all at once.</p>	 <p>The screenshot shows the editGPT interface with a toolbar at the top containing buttons for Grammar, Light, Proofread, Streamline, Improve, Undo, Accept, Reject, Rewrite, Formal, Natural, Accept All, Reject All, Copy, Clear, and Fine-tuned. A tooltip over the 'Improve' button reads 'Proofread this and improve clarity and flow'. The main text area contains a paragraph with several red and green highlights indicating edits. The text is as follows:</p> <p>INTRINSIC MOTIVATION.</p> <p>The role of employees, supervisors, and MASs are^{is} investigated as a part of controls. For the employee, autonomy plays a key role in <u>in relation to controls. Specifically, autonomy is found to be an important factor in the study conducted by</u> Grasser et al. (2021) where. In this study, participants were either given the <u>option</u>choice to contribute to control design or to not contribute. Participants, proxied for employees, were subjected to <u>not. Participants, who represented employees, were then involved in</u> a prisoner's dilemma task where upon a performance shock was administer <u>used</u> to manipulate performance and induce<u>encourage</u> cooperation among peers. The research found that <u>revealed that the level of</u> contribution involvement moderates the effe<u>impacts</u> of incomplete feedback toward <u>on</u> cooperation among peers, highlighting the rel<u>significanc</u>e of implicit motivation and autonomy. In a related <u>fashions</u>similar study, Hartmann and Slapnicar (2009) conduct a study on bank managers to determine whether <u>the formality</u>examined the effect of feedback affects<u>formality on</u> trust between supervisors and subordinates <u>in the context of</u> <u>bank managers</u>. Their findings <u>further support the</u> valu<u>importance</u> of implicit motivation.</p>
----------------	--	---

<p>Isaac Editor</p>	<p>Suggested edits, powered by Grammarly, provide specific justification.</p>	 <p>(2010) suggests that feedback proximity enhances nts pre isplayed feedback manipula t pient p low-pe lback. eedbac</p> <p>Change the verb form</p> <p>... 2010) suggests suggest that feedback ...</p> <p>It appears that the singular verb suggests does not agree with the plural compound subject Hodge et al. (2010). Consider changing the verb to the plural form.</p> <p>Accept Dismiss ...</p> <p>Suggested by Grammarly</p>	 <p>ISAAC Here is a short version of your highlighted text:</p> <p>Maiga and Jacobs (2005) found that more frequent feedback is preferable in a TQM plant. However, Holderness et al. (2020) discovered that there is a limit to the effectiveness of feedback frequency. Initially, increasing feedback frequency improves performance, but after a certain point, further increases in feedback actually decrease performance. Thornock (2016) determined that delaying feedback also has diminishing returns. Immediate feedback after a multi-step task enhances</p> <p>Chat Context</p> <p>Isaac Isaac's base model & infinite chat history</p> <p>References All your uploaded papers & documents. ></p>
<p>Isaac Editor</p>	<p>Left: Selected text can be manipulated in several different ways.</p> <p>Suggested manipulations are presented for approval or adjustment.</p>	<p>evaluation creation and distribution, has a positive effect on trust between the subordin</p> <p>Ask Isaac B i U < > @ ☐ ontributions to output.</p> <p>Manipulate Text</p> <ul style="list-style-type: none"> Summarize Paraphrase Expand Improve Shorten Bullets to Text Custom <p>Utilities</p> <ul style="list-style-type: none"> AI Detector Find Sources Explain <p>back Recipient</p>	 <p>Maiga and Jacobs (2005) show that mo total quality management (TQM) plant environment. Holderness et a on the effectiveness of feedback frequency, indicating that an incre mproves performance but thereafter increases in feedback reduce pi that a timing delay in the issuance of feedback also exhibits diminish mediately after a multi-step task improves performance on following diminishes rapidly after a delay. Performance with significantly delay ance without feedback.</p>

Panel D: Presentation Support

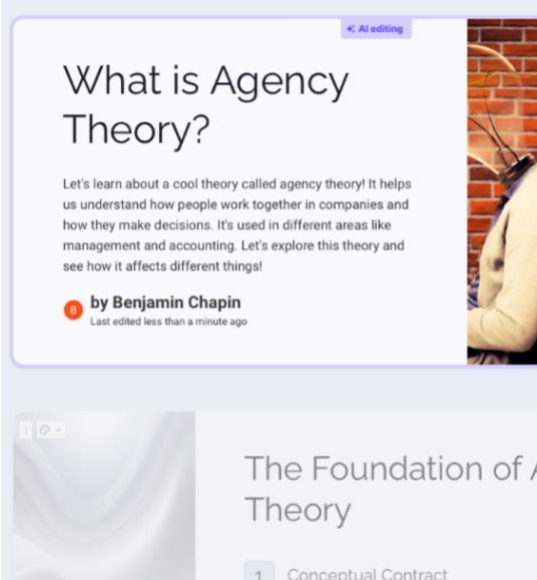
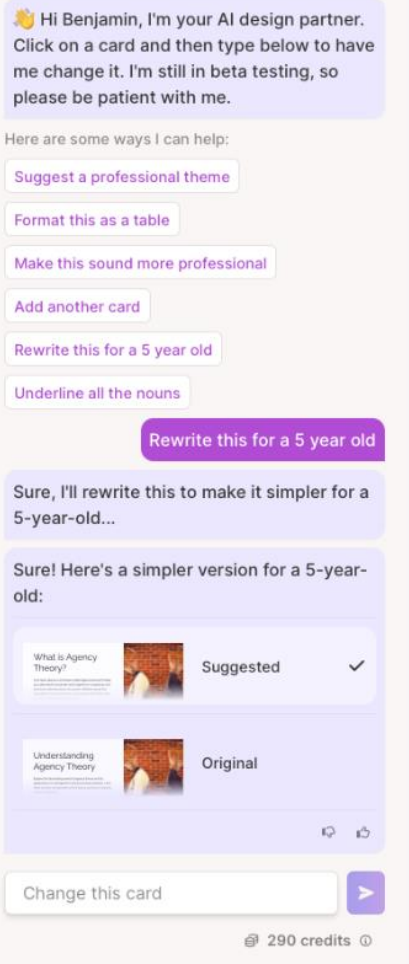
<p>Gamma</p>	<p>Editing with AI is an interactive process.</p> <p>Text and tone can be adjusted to better match with the intended audience.</p> <p>A chatbox allows for edits to be reviewed and approved.</p>		
--------------	---	--	--

Table 1. Overview Tools**Panel A: Literature Search and Summarization**

AI Tool	Website	Use-case	Cost ²⁸
Semantic Scholar	www.semanticscholar.org	Academic search engine	Free
Consensus	consensus.app	Academic search engine	Free/\$10 monthly/\$84 annually
SciSpace	typeset.io	Article understanding	Free/\$20 monthly/\$144 annually
Scite	scite.ai	Finding citations	\$20 monthly/\$144 annually
Elicit	elicit.com	Article critique	\$12 monthly/\$120 annually
Connected Papers	www.connectedpapers.com	Literature visualization	Free/\$24 quarterly/\$60 annually
Research Rabbit	www.researchrabbit.ai/	Literature visualization	Free

Panel B: Data Collection

Tool	Website	Best use-case	Cost
ChatGPT	chat.openai.com	Questionnaires web scraping o-tree/z-tree	\$20 monthly

Panel C: Statistical Analysis

Tool	Website	Best use-case	Cost
ChatGPT	chat.openai.com	Interpretation and refining code	\$20 monthly

Panel D: Writing Support

Tool	Website	Best use-case	Cost
ChatGPT	chat.openai.com	Copyediting	\$20 monthly
editGPT	https://editgpt.app	Composition and editing	Free/\$10 monthly/\$90 annually
Isaac	isaaceditor.com	Composition and editing	Free/\$11 monthly/\$84 annually

Panel E: Presentation Support

Tool	Website	Best use-case	Cost
Gamma	gamma.app	Slide Preparation	Free/\$10 monthly/\$96 annually

²⁸ Costs are provided for student or academic plans. Many of the AI tools in our selection have options for non-academic individual or commercial licenses, but the price for those options is typically higher.

Table 2. Standard Prompting versus Chain of Thought (CoT)

Standard Prompting	Chain of Thought (CoT) Prompting
<p>Model Input:</p> <p>Q: A 2x2 experiment has 165 subjects signed-up. Subjects must be paired into groups of 10. An additional 45 subjects sign up. Each session can take one group. How many total sessions do you need?</p> <p><i>A: The answer is 21.</i></p> <p>Q: Another experiment had 23 subjects. If 20 participated in a study and an additional 6 signed up, how many participants remain in the pool?</p>	<p>Model Input:</p> <p>Q: A 2x2 experiment has 165 subjects signed-up. Subjects must be paired into groups of 10. An additional 45 subjects sign up. Each session can take one group. How many total sessions do you need?</p> <p><i>A: The experiment started with 165 subjects. 45 more subjects are $165 + 45 = 210$ subjects. Subjects are sorted into $210/10 = 21$ groups of ten. There are 21 and each session takes 1 group. The answer is $21/1=21$ sessions.</i></p> <p>Q: Another experiment had 23 subjects. If 20 participated in a study and an additional 6 signed up, how many participants remain in the pool?</p>
<p>Model Output:</p> <p><i>A: The answer is 27</i></p>	<p>Model Output:</p> <p><i>A: The experiment had 23 subjects. 20 participated. Now there are $23-20 = 3$ subjects in the pool. An additional 6 subjects signed up, so now they have $3 + 6 = 9$. The answer is 9.</i></p>

Table 2 illustrates the Chain of Thought (CoT) prompting technique, which is utilized to enhance the response of a large language model to a query. This technique involves providing contextual information alongside the query using a series of reasoned statements. As a result, the AI model's response is restricted to a relevant and exceptionally precise answer. We adapted the prompting from Wei et al. (2022).