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Examining the Interplay among AI, Dissertation Writing, and Critical Thinking Skills: A Mixed-Methods Study of Doctoral Students

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Abstract

The exponential adoption of Artificial Intelligence (AI)-powered tools in academia has reshaped the writing practices of Moroccan doctoral students conducting research projects. This study examines the extent to which Moroccan doctoral students use AI tools in dissertation writing and assesses the relationship between AI usage and critical thinking (CT) skills. Adopting a mixed-method explanatory sequential design, ninety-three conveniently selected doctoral students completed a designed Artificial Intelligence and Critical Thinking in Writing scale (AICTW), while fifteen participants underwent semi-structured interviews. Through descriptive, Pearson correlation, regression, and thematic analyses, the results revealed that doctoral students adopt AI-powered tools and Generative AI (GenAI) for tasks such as identifying research gaps, improving writing efficiency, and analyzing data. The correlational analysis demonstrated a moderate positive relationship between AI use and CT skills, indicating that students who frequently engage with AI tools tend to exhibit higher CT skills. Furthermore, the qualitative data revealed positive attitudes toward AI use in dissertation writing; however, participants also expressed concerns related to plagiarism, heavy reliance, and memory weakening. The findings highlight the need for more research into the influence of AI tools on higher-order thinking skills and for promoting AI literacy and deeper analytical thinking among doctoral students and researchers.

Keywords: artificial intelligence, AI tools, critical thinking, doctoral students, dissertation writing

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1. Introduction

In modern e-learning environments, Artificial Intelligence (AI) has become a requisite component of how students interact with educational materials and learn more generally. Not only do AI tools provide immediate feedback, but they also deliver personalized learning experiences tailored to students from a wide range of academic backgrounds (Huang, 2025; Yaseen et al., 2025). Moreover, the use of AI has been reported to not only enhance students' cognitive skills but also support learners with cognitive disabilities (Alnfiai et al., 2025). AI has positively affected problem-solving, creativity, and mental well-being (Abrar et al., 2025). For instance, Haider et al. (2024) found that AI tools significantly improved students' cognitive functions, namely memory retention and problem-solving.

The perceived impact of AI tools on higher-order thinking skills is another aspect that has sparked robust debate among educators. Studies have examined the influence of AI tools on different higher-order thinking skills, including metacognition (Dahri et al., 2024; EL Hosayny et al., 2026) and critical thinking (CT) skills (Darwin et al., 2023). For instance, in an experimental study by Liu and Wang (2024), students who used AI tools showed statistically significant improvements in CT skills compared to those who did not. Conversely, overreliance on AI may lead to a surface-level understanding and impede the development of CT skills (Faisal, 2024; Hading et al., 2024).

Given AI's great potential to improve learning outcomes, its use in advanced academic processes like dissertation writing warrants close examination of how it shapes users' CT skills, especially as AI tools are becoming integral to the thesis-writing process for most doctoral students. Findings from a study by Schwenke et al. (2023) revealed that ChatGPT assisted them with brainstorming, structuring, and revising text. Similar findings were reported by J. Kim et al. (2025), whose participants indicated that AI-assisted writing tools offered full support, enhancing both the writing process and performance. Despite the many benefits of AI tools, little is known about their relationship to doctoral students' CT skills in dissertation writing. Within the national context, few studies have examined the relationship between the two variables.

At the international level, most studies have examined the interaction between AI and CT using either quantitative approaches (Fabio et al., 2024; Suriano et al., 2025) or qualitative approaches (EL Hosayny et al., 2025; Darwin et al., 2024). Hence, there is a scarcity of mixed-methods studies examining the relationship between AI and CT in doctoral research. The objectives of the study are three-fold. The current study aims to investigate the diverse ways doctoral students

use AI tools in academic writing. It explores whether their use of AI tools inhibits or fosters their CT abilities. Lastly, the study also examines the perceived benefits and drawbacks of AI use in their doctoral research. Therefore, this study aims to answer the following three research questions:

1) To what extent do Moroccan doctoral students use AI tools in dissertation writing?
2) To what extent does the use of AI tools correlate with CT skills and dissertation writing among Moroccan doctoral students?
3) What are doctoral students' perceptions of AI tools in dissertation writing?

2. Theoretical Framework and Literature review

Pioneered by Benjamin Bloom in the 1950s, Bloom's taxonomy is recognized as a key educational framework that outlines the sequential stages of learning, ranging from basic theoretical knowledge to more advanced tasks, such as problem-solving and CT (Nentl & Zietlow, 2008). Anderson and Krathwohl (2001) proposed a revised version of the taxonomy that further elaborates on these cognitive levels (Tabrizi & Rideout, 2017). Anderson et al. (2001) suggests categorizing human thinking skills into six levels: remembering, understanding, applying, analyzing, evaluating, and creating. The updated taxonomy comprises six cognitive levels, expressed as action-oriented verbs rather than nouns, unlike the original version. Those six levels of cognition, as described by Borich (2016), are classified into two categories: lower-order thinking skills (LOTS) and higher- order thinking skills. Placing heavy emphasis on the HOTS fosters CT skills (Ekalia et al., 2022). Nurmatova and Altun (2023) describe the six stages of learning from the revised version as follows:

- **Remembering:** This stage involves remembering and understanding previously acquired information.
- **Understanding:** This stage entails grasping the content's meaning and providing a personal explanation in one's own words.
- **Applying:** At this stage, application of ideas and methods to problem-solve is fostered.
- **Analyzing:** At this level, learners analyze complex information, recognize patterns, and identify relationships.
- **Evaluating:** This stage involves evaluating information by judging it and constructing arguments.
- **Creating:** At this stage, learners generate new ideas by combining prior knowledge with new ones.

Bloom's Taxonomy framework was initially developed to enable teachers to systematically classify educational objectives and cognitive processes in learning (Adesoji, 2018). Beyond its role in helping educators structure learning objectives, Bloom's Taxonomy also serves as a scaffolding tool that encourages students to assess their current level of thinking, thereby allowing them to use the taxonomy as a guide to advance their higher-level thinking (Athanassiou et al., 2003). Through engaging in self-reflection and analysis, doctoral students can recognize their cognitive levels in academic writing. Building on this, the present study employs the revised version of Bloom's taxonomy to assess the use of AI tools among doctoral students and their influence on higher-order thinking skills (HOTS) in dissertation writing. In particular, it explores how Moroccan doctoral students critically analyze content, evaluate resources, and generate new research ideas.

2.1. The use AI tools in dissertation writing

With the current advent of AI in academia, its integration into dissertation writing is becoming pervasive among researchers. According to a study conducted by Lopes et al. (2024) in Brazil, 84.5% of graduate students utilize AI tools for text generation; however, they reportedly lack an understanding of their full potential. In a further study conducted in the United States, doctoral students were reported to use AI tools for content generation, automated feedback, translation, and data analysis, which promoted independent learning, enhanced CT, and helped manage research-related challenges (Wan et al., 2024). Similar findings were reported in a study by Royani and Sihombing (2024), who found that students use AI tools such as ChatGPT to generate ideas, draft content, and receive guidance on research structure and organization, thereby supporting dissertation writing. However, it is crucial to acknowledge the potential downsides of AI use on writing skills. Royani and Sihombing (2024) expressed their concerns about the overreliance on AI tools, stating that such overdependence diminishes creativity and CT skills.

2.2. Perceived impact of AI on CT skills

Research has shown that the integration of AI in education can strengthen students' CT skills. A study by Fan (2024) shows that AI enhances students' CT skills in art classes by helping them analyze and evaluate artworks and prompting deeper inquiry. Furthermore, findings from a study on leveraging ChatGPT to enhance English writing skills and CT among university freshmen show that ChatGPT fosters CT by encouraging students to assess their writing, reinforcing their analytical and evaluative skills (Minh, 2024). On the other hand, research reveals that AI can, in fact, support logical reasoning and data analysis; however, it lacks the

ability to develop deeper CT, address complex ethical issues and engage in philosophical discourse, which are crucial human skills for meaningful learning (Baruwa, 2024); therefore, AI cannot replace complex human qualities.

Although AI tools have the potential to improve students' CT skills, concerns have been raised about the dangers of overreliance on these tools, especially in dissertation writing. That is to say, AI can diminish cognitive engagement. For instance, reliance on AI tools such as ChatGPT can undermine students' judgment, problem-solving, and knowledge integration, all of which are imperative for academic writing (Koos & Wachsmann, 2023). Aljuaid (2024) points out that the reliance on automated assistance can lead to superficial understanding of complex concepts. Overall, there is inconclusive evidence pertaining to the perceived impact of AI on CT skills. While AI has shown potential to improve reasoning and stimulate CT, it remains limited in its ability to enhance creativity.

3. Methods

3.1. Research design

This study employed a mixed-methods approach using an explanatory sequential design, combining quantitative and qualitative insights to deepen understanding of doctoral students' use of AI tools to enhance CT and academic research. This design followed a two-step process, in which quantitative data was first gathered and analyzed. Subsequently, qualitative data were collected and analyzed for further interpretation and cross-validation (Yachoulti et al., 2023). Using quantitative data, the relationship between students' use of AI tools in academic writing and their CT skills was assessed using statistical analyses. The qualitative data are tailored to explore the perceived benefits of using AI, as well as its limitations and drawbacks in writing among doctoral students.

3.2. Participants

The target population of the current study was Moroccan EFL doctoral students majoring in different fields such as neurolinguistics, media studies, chemistry, medicine, political science, English, and Arabic at various Moroccan institutions. Ninety-three doctoral students, including 51 males and 42 females, were conveniently selected. The participants had diverse academic years in their doctoral studies, including first year (N=43), Second year (N=24), and third year and above (N=26). It is worth noting that, despite the majority of participants being first-year doctoral students, they are expected to engage in thesis-related tasks from the beginning of the doctoral program, including writing research proposals, literature review chapters, and coursework.

With regard to the participants for the qualitative part, fifteen doctoral students, 8 males and 7 females, were purposively selected based on their English language proficiency level and experience in using AI tools. The participants' ages ranged from 24 to 36 years, with a mean age of 27.83 (SD = 3.50). Each participant was identified by a unique code and pseudonym to maintain strict confidentiality and anonymity. All participants had at least 2 years' experience actively using a variety of AI tools, such as natural language processors (ChatGPT, Copilot, Gemini) and writing assistants (Grammarly, QuillBot). Moreover, each participant demonstrated advanced English proficiency, as verified by their Rosetta Stone scores.

3.3. Data Collection Tools

3.3.1. *AICTW Scale*

To examine the association between AI use in dissertation writing and CT skills among doctoral students, an Artificial Intelligence and CT in Writing scale (AICTW) was developed. The scale consists of 50 items classified into four main parts (See the Appendix). The first part aims to gather demographic information about the participants, including their doctoral program and the university they belong to. The second part was designed to help doctoral students become acquainted with the AI-powered tools they use in their academic writing. The third part of the questionnaire sought to gather data on the use of AI tools in dissertation writing. It is divided into five subsections: Literature Review and Research, Writing and Structure, Data Handling and Visualization, Drafting and Editing and Creativity and Productivity. Each subsection includes four items to ensure adequate coverage of the writing and research skills while maintaining brevity. The design was informed by a study by Guhan et al. (2023), from which questionnaire items were drawn and adapted to better align with this study's research questions and to reflect specific aspects of AI use in academic writing. The validity of the scale items was also assessed and confirmed by experts' opinions.

For the fourth and final part on CT skills, Bloom's taxonomy provided a comprehensive framework for identifying CT abilities in dissertation writing. The statements were designed utilizing key action verbs of the revised version from each cognitive level – Remembering (N=4), Understanding (N=4), Applying (N=4), Analyzing (N=4), Evaluating (N=4) and Creating (N=4) to assess whether doctoral students effectively used the lower-order thinking skills (LOTS) and the higher-order thinking skills (HOTS) in their writing. The scale used a 5-point Likert response format, with options from 1: Strongly Disagree to 5: Strongly Agree.

The reliability of each subscale in the questionnaire was substantiated using Cronbach's Alpha test. The values of Cronbach's Alpha ranged between 0.97 and 0.76, which indicated good internal consistency for each scale. The internal consistency analysis of the instrument demonstrated good reliability, highlighted by a Cronbach's alpha (α) value of .88.

3.3.2. *Semi-structured Interview*

To have a deeper understanding, fifteen participants were interviewed to collect delicate insights. According to Guest et al. (2006), data saturation can happen as few as with 12 participants in homogeneous groups. The semi-structured interview was designed and informed by numerous scholarly works including Darwin et al. (2024), Muthmainnah et al. (2022), and Nguyen et al. (2023). The interviews were conducted at the participants' approved dates and times. The interview was composed of thirteen questions designed to elicit doctoral students' use of AI applications, the perceived impact of AI on CT and dissertation writing, and the limitations and drawbacks of AI in navigating the academic endeavors.

3.4. Procedures

After securing ethical approval from our institution, Moulay Ismail University, we conducted a pilot study on February 3, 2025, involving 20 participants to assess the scale's reliability and clarity. Although bigger samples are encouraged for pilot testing, the literature advocates for the use of smaller pilot groups when the purpose is to adjust the instrument and generate statistical estimates (Van Teijlingen & Hundley, 2002). Based on the feedback, necessary adjustments were made to enhance the instrument's reliability. More specifically, the last item under the create section, "*I can design effective research strategies,"* had an alpha level of 0.41. This was revised to: *I can generate original hypotheses that are tailored to the focus of my study, resulting* in an improved alpha level of 0.782. On the same day, the finalized questionnaire was shared with doctoral students via various online platforms to ensure broad dissemination among the student body. Participation was entirely voluntary, and participants were assured of the confidentiality and anonymity of their responses. The collection of quantitative data spanned approximately one week, allowing sufficient time for respondents to complete the survey.

3.5. Data analysis

Upon completing data collection, the researcher used descriptive statistics to summarize and present demographic information about the participants and their familiarity with AI tools. In addition, a correlational analysis was conducted in SPSS (v27) to investigate the relationship

between AI use and CT skills among doctoral students, with variables computed to obtain total scores for AI use and CT skills.

After the quantitative data collection and analysis, a semi-structured interview protocol was designed to further support the quantitative findings. Fifteen interviewees were selected based on their willingness to engage in further discussion. The interviews were scheduled via online phone call with each participant based on their availability and their convenience, ensuring minimal disruption. At the beginning of each interview, a brief introduction was provided to inform participants about the purpose of this study, the interviewer's background, and the confidentiality of the recorded responses. This introduction helped establish rapport and a comfortable environment for discussion. The interviews lasted an average of 20 minutes. For the qualitative data analysis, NVivo (v15) was used to code and organize the data. The recorded interviews were transcribed in Word and analyzed using thematic analysis to identify emerging themes in the responses.

4. Results

4.1. Quantitative results

4.1.1. *Moroccan doctoral students use of AI tools in dissertation writing*

The majority of participants (90.1%) reported using AI tools to write their dissertations, whereas only 9.9% reported not using them, suggesting that AI tools are widely adopted by doctoral students in the academic writing process. ChatGPT, Gemini, Grammarly, QuillBot, Zotero, Mendeley, Connected Papers, Research Rabbit, Notebook and Overleaf were widely used AI tools among doctoral students. Among these AI tools, ChatGPT and Grammarly are the most frequently utilized.

The participants employed AI tools for various tasks, including reviewing the literature primarily to identify research gaps, enhancing their efficiency in the literature review process, and helping them discover relevant research for their topics. A moderate use of AI tools in the review of the literature was reported, with M=3.41, SD=.995, suggesting that, on average, students use AI tools moderately in their literature review. Table 1 summarizes the use of AI tools in different sections and purposes for dissertation writing.

Following their use of AI tools in reviewing the literature, doctoral students clearly used AI tools in their writing and in structuring their dissertations. Students reported that AI tools have improved the structure of their writing, helped them paraphrase and summarize effectively, and reduced errors. The mean (3.45) indicates moderate to frequent use of AI for writing and structuring among Moroccan doctoral students.

Table 1. *Descriptive statistics of students' use of AI tools in dissertation writing*

	Mean	Std. Deviation
AI_for literature review	3.4148	.99528
AI_for_writing	3.5357	1.02305
AI_for_data handling and visualisation	3.3819	1.11077
AI_for_drafting and editing	3.5000	1.03481
AI_for_creativity	3.1071	1.06923

In a similar vein, the participants also utilized AI tools for data handling and visualization. Notably, doctoral students noted that AI tools have made data analysis much easier, enhanced their ability to interpret statistical findings, improved data visualization and helped them present complex data. With an average score of 3.38, students engaged with AI tools for data handling and visualization at a moderate level.

Drafting and editing were other stages where students utilized those AI tools. The latter were reported to have accelerated drafting, minimized proofreading and editing time, and improved their communication of research findings. The mean (3.50) reflects moderate-to-frequent engagement with AI tools for drafting and editing among Moroccan doctoral students. Doctoral students used AI tools to enhance their research creativity, produce more impactful research outcomes, make research decisions and to improve the overall quality of their work. The mean (3.10) indicated moderate engagement with AI tools to foster creativity and productivity. Overall, the results showed that students used various AI tools across different sections of their dissertations to streamline the research process and improve efficiency.

4.1.2. *The correlation between AI use and CT skills in dissertation writing*

Table 2 shows Pearson correlations between literature review, writing, data handling, creativity and artificial intelligence. All variables show a highly significant positive correlation between AI use and dissertation writing. When it comes to creativity and AI, a significant positive correlation was observed, suggesting that the more students utilize AI tools, the more their creativity increases.

Table 2. *Pearson´s correlations between AI literature review, AI and writing, AI and data handling, AI and creativity*

Variable	*r*
AI use and literature review	.827**
AI use and Writing	.878**
AI use and data handling	.834**
AI use and creativity	.806**

**Correlation is significant at the 0.01 level (2-tailed).

Table 3 presents Pearson correlations between CT skills (remember, apply, understand, analyze, evaluate, create) and the use of artificial intelligence. The majority of constructs showed a positive and moderate correlation with CT skills. For instance, a moderate-to-strong statistically significant correlation (R=0.459) was observed between remember and AI. This implies that utilizing AI tools can better enhance information recall and the synthesis of relevant ideas.

While moderate positive correlations were found between understand, apply, analyze, and AI, the latter did not strongly correlate with creating skill. This signifies that students who utilize AI to create content and identify research gaps may affect their ability to create original content. Overall, the correlational analysis between AI use and CT skills revealed a moderate positive correlation ($r = 0.388$) and a statistically significant p-value ($p = 0.000$), both less than 0.5 and 0.01, respectively. Since the correlation coefficient remains below 0.5, the relationship is moderate rather than strong.

Table 3. *Pearson correlations between AI and CT skills*

Variable	*r*
AI and remember	.459**
AI and understand	.385**
AI and apply	.409**
AI and analyze	.334**
AI and evaluate	.237*
AI and create	.170

**Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

A linear regression analysis was also conducted to assess the independent variable's predictive power and its contribution to predicting CT skills. The multiple linear regression analysis assessed the predictive effect of CT skills (dependent variable) and the predictors (the use of AI tools). All the variables were imported using the stepwise method based on their statistical significance. The data yielded significant results, confirming those obtained in the correlation model. The regression model demonstrated that the use of AI tools significantly predicted CT skills ($\beta = .362$, $t = 3.970$, $p < .001$). In short, higher levels of AI tool use can contribute to heightened awareness of CT skills.

4.2. Qualitative findings

To answer the third research question, qualitative data were collected through semi-structured interviews with fifteen doctoral students upon the completion of the quantitative analysis. A thorough reflective thematic analysis of the interviews revealed several common themes that shed light on the students' positive perceptions and experiences with AI tools in enhancing their

dissertation writing and CT skills, as well as their awareness of the limitations and weaknesses of these tools.

4.2.1. *Students´ perceived usefulness and positive attitudes towards use of AI in academic research*

The interview findings indicated that the participants generally held a positive attitude toward the use of AI tools in academic writing, especially for improving linguistic accuracy, facilitating brainstorming and information retrieval, and therefore enhancing their overall research productivity. For JE, AI tools, namely ChatGPT and Grammarly, are valuable assets for refining sentence structure, establishing coherence and cohesion of writing, and facilitating more precise communication.

> *In relation to ChatGPT it made my language better because whenever I like something I would ask them if that thing were correct……. for Grammarly I have used it when I was in when I was doing my master's thesis, I had first used it in order to correct the grammar because I noticed that I have been using the same linking words over and over through the whole pieces (JE)*

Furthermore, GenAI is regarded as a tool that helps students gain a broad understanding of the topics and familiarize themselves with concepts that they are tackling before delving into in-depth research using credible academic resources. This allows students to identify and grasp relevant basic concepts and lay a foundation. For instance, HF explained:

> *Yeah, I'll tell you: before looking for a suitable theoretical framework, for example, I search the internet and use ChatGPT to find general information to get a clear idea. Then I go to credible sources of indexed journals, let's say journals, to look out for the specific information I already found (HF).*

Not only does GenAI aid students in comprehending key concepts, but it is also efficient at providing references for academic work. However, the mere extraction of content without verifying the credibility remains inadequate, as YC mentioned:

> *I sometimes use AI to find specific information faster. In my work, most of us need proper references. We can't just go and search like this, find the information and then take it. No, we need the information, and it needs to be cited from, like, a research article. So, the AI does give this. Uh, source of the information. There's one called Perplexity. Yeah, I use it because it gives me the source (YC).*

4.2.2. *Perceived impact of AI tools on CT skills*

Although the participants expressed a generally positive attitude toward AI use in academic writing, they remained highly cognizant of the predominant role that CT plays throughout the writing process. While AI tools assist students in understanding research concepts and improving linguistic accuracy, the imperative of critical engagement and the ability to evaluate and critique AI-generated information remain essential to producing high-quality dissertations. For example, FT expressed:

> *I think if one already has critical thinking ability, it is developed in a way that it's learning from a person on the other side. So, you should really ask a good question properly that enables AI to correct information correctly; meanwhile, when you receive the information, for example, you approach it critically; maybe something was wrong. Maybe it's not updated. Maybe it is not legal. So critical thinking should be present to use the tool properly. (FT).*

Further, students who use AI tools and GenAI in writing are more likely to develop analytical and intellectual discernment, since they require assessing the reliability of the information provided. NB stated:

> *So, imagine we have two outputs, right? And you are looking for a particular topic. Whatever the input of the first software, we have it as a baseline for comparison with the second software. So here it's like evaluating 2 outputs…… I think AI makes it easier (NB).*

Accordingly, FD also stated:

> *AI will help me. If I use it smartly, if you ask me this question two months or three months before, I will say it will hinder my skills, but now as I come to use this AI, it's quicker; I realized that, to some extent, they are beneficial. They can help you as long as you use them smartly and don't rely on them (FD).*

On a similar note, MF underlined the importance of critical rather than passive engagement with AI tools, as well as seeking further knowledge and content from diverse and credible sources, by stating:

> *AI makes it easier in a way that it finds information for you, but the analytical question should be raised by you to AI and to yourself. Or is it enough? Because whatever AI answers, do you find it enough? Do you have any hunger to find out*

more about it so they go alongside together…… It's my personal opinion so far. Easier, yes. And if something makes it easier, it should be used (MF).

Hereof, interviewees perceived AI tools as assistive tools in the writing process; however, they should not be considered primary sources of knowledge or a replacement for scholarly work. Despite all the perceived benefits of AI tools on dissertation writing, potential limitations and drawbacks may arise.

4.2.3. *Students' acknowledgment of limitations and drawbacks of AI*

The qualitative data findings additionally shed light on the limitations and drawbacks of AI use among Moroccan doctoral students, which can be categorized into two main themes: those directly related to the AI tools themselves and those reflecting the impact of AI use on doctoral students.

4.2.3.1. Limitations associated with AI tools

- ***Plagiarism issues***

The informants voiced apprehension about the use of AI in academic writing regarding authorship and the originality of the work. NJ raised concerns regarding the potential loss of authenticity, which can lead to plagiarism, stating that *"*Plagiarism, the style of writing, if the student is impacted by the artificiality, it is no kind of authenticity at the level of the style of writing of the researcher". NJ further explained how the researchers' knowledge will be shaped by the generated content of AI tools rather than by their own reality, and how this will distort their intellectual agency, describing it as a "power relationship". This participant claimed that "*the common knowledge of the researcher is not the same if he starts using such a platform. So, it's a power relationship, let's say impact, actually that may distort the reality of the researcher*". Sharing the same opinion, TK draws attention to plagiarism by stating: *It's not acceptable to take a sentence like this as your own. I think the same standards apply to plagiarism. Plagiarizing others' words applies to AI. So that would be one aspect that involves the unethical ramifications of AI (TK).*

- ***Limited access to data***

One major limitation raised by a participant is that AI tools have restricted access to data, meaning they cannot access proprietary databases. Therefore, AI-generated output is not sufficient and may lack depth, particularly in research fields that rely on sensitive information or human interaction. Unlike humans, who can access confidential datasets and archives that

are not publicly available, AM explained: *"Maybe AI don't have access to closed databases." Closed information.*

> *If it's secret information or personal data that's not public, I don't know if it has access to anything on the Internet; it can be on some safe server. I don't know if it can reach, but as a human, you can always get firsthand or second-hand access to the information you might need for your research (AM).*

- ***Subjectivity and AI bias***

The interview findings indicate that AI-generated content can contain societal, cultural, and political bigotry and bias, reflecting subjectivity. As a result, doctoral students who do not critically examine AI output can risk falling into biased information and reinforced ideologies. P4 declared:

> *The ethical concerns: biases should be taken into consideration. AI bias exists, so it's something that should be taken into consideration, whether you are preparing your dissertation or not. Even in critical thinking itself, I still believe that AI can still involve some kind of political bias or sometimes cultural bias. So, I think bias is an important concern when it comes to it (P4).*

Beyond the inherent constraints of AI tools, the way doctoral students use AI can negatively affect their cognitive skills, motivation, research endeavors, and academic integrity.

4.2.3.2. Drawbacks of AI use on doctoral students

- ***Heavy reliance on AI***

The findings raised concerns about the heavy reliance on AI and its impact on students' cognitive development. It has been reported that students use AI to complete assignments rather than actively engaging with the material, leading to a lack of initiative. For instance, MB stated that *"I would say, maybe we can't see it right now, people are like instead of doing some homework. They give it to AI, right? And we know that the positive for doing homework we do homework to learn".* MB additionally emphasized a significant societal issue regarding AI's potential to undermine the quality of learning by reducing students' engagement and intellectual effort among students in developing countries, where the improvement of higher education is pressing. The same informant declared that *"AI is decreasing the quality of learning right now, it's going down with AI, especially in improving country, we are improving country, and we should be improving, and AI is making the process harder, especially in higher education".*

Moreover, overreliance on AI tools extends beyond academic tasks; it is integrated into daily activities and personal interactions, weakening students' ability to think independently. MB added:

> *Yes, that's the problem. The second thing is that we should not think that AI can think instead of us. I've seen people rely on AI to the point where they ask how to reply to a friend or, like, a potential partner. So, these are very negatively impacting things; we should only rely (MB).*

In short, participants described heavy reliance on AI tools can lead to reduced engagement in independent thinking during the research process. They reported that frequent dependence on AI limited the need to critically process, evaluate, and develop ideas independently.

- ***Lack of reliance on Memory***

According to two participants, the use of AI tools can negatively influence their memory. AI is changing the way education is seen since recalling information is no longer a requirement, as BN describes:

> *Since education is really changing and it's becoming the question every time, what education should look like and what it should serve in these days…… Everything is more about analytical thinking, where knowing something by heart isn't really a requirement because you can always search; everyone has a phone, or a computer…(BN).*

Overall, the participants described AI use as reducing the need to recall information independently. They reported that information could be accessed through AI tools rather than memorized. They also associated AI use with changes in how they approach remembering and retrieving information during learning. These accounts highlight participants' perceptions of a reduced emphasis on recall in educational contexts.

4.2.4. *Ethical concerns regarding publications*

According to an interviewee, doctoral students who use AI, particularly advanced AI tools to generate article content, may engage in unethical publishing. The participant quoted: "*I think the biggest issue is that, like, those who have access to this AI will be able to write articles more easily, and then they will have, like, a higher number of publications. However, it's not really their work"* (OF).

This, in turn, calls into question the authenticity of the publications and their harmony with academic integrity. Additionally, the participant perceived these practices as unfair for students

who invest substantial time and energy in conducting original research, which necessitates high levels of CT, cognitive engagement, and overall research skills. Moreover, OF stated that *"it wouldn't be really fair for other people who put like real physical effort into doing research and writing and analyzing the data and all of that"*

4.2.5. *Cheating and superficial analysis*

One significant drawback of AI in education is the spread of cheating and misconduct. As SE claimed, students tend to use AI at the expense of their own effort. For some users who rely on AI for analysis, it has been shown to be shallow and lacking depth, which may hinder CT and reflective analysis. As one of the informants claimed:

> *A limitation of AI tools, from my use what I need. It doesn't go deep. This is the first one. Second one. Is that? You can get caught. I'm talking mainly about, as I said, ChatGPT. This is the most frequent use… I don't like its writing style……It doesn't help them. Yes, it doesn't help them develop critical thinking skills, cause most users use AI tools to do the work instead. They do that because they don't even read. Some students choose to cheat (SE).*

Therefore, participants linked AI use to increased opportunities for cheating and academic misconduct, particularly when students rely on AI to complete tasks instead of making their own contributions. Heavy reliance was further associated with reduced engagement in critical and reflective analysis, as participants described AI-assisted work as sometimes superficial and lacking depth.

5. Discussion

Generally, the quantitative and qualitative findings indicated that Moroccan doctoral students held positive attitudes toward using AI tools in dissertation writing. Notably, 90% of participants who completed the survey reported using AI tools in academic writing. This high rate suggests that AI is deeply embedded in doctoral studies, potentially substituting traditional academic support, namely supervisors or peer feedback. These tools are reported to be used not only for surface-level editing but also across the various complex stages of writing a dissertation, such as data handling and refining research questions and methodologies. This aligns with the study by Iatrellis et al. (2025), which indicates that ChatGPT can enhance PhD supervision by offering academic guidance and reducing administrative burden.

Among these AI tools, ChatGPT and Grammarly are the most widely utilized. The most prominent areas in which doctoral students employed AI were literature review, with a mean

of 3.14, particularly for identifying research gaps and searching for relevant studies. These findings align with those of Oliveira et al. (2024), who report that AI-powered tools such as Zotero and Mendeley help doctoral students review the literature and organize references. Similarly, interviewees perceive GenAI as a tool that helps students gain a general understanding of the topics and become acquainted with research concepts before tackling in-depth research using credible scholarly resources. This frequent use of AI tools in the early stages of research can be attributed to overcoming writer's block and providing a sense of momentum. Gilburt (2023) supports this finding, proposing that LLMs like ChatGPT might be used to address writing challenges, particularly writer's block. However, this reliance on AI can diminish students' active engagement in developing their own critical voice and research direction. As Zhai et al. (2024) disclosed, overreliance on AI tools decreases analytical thinking skills and reasoning, which can foster complacency and reduce students' inclination to engage in independent, critical information analysis among students.

An additional area in which Moroccan doctoral students employed AI tools was writing and structuring, as well as data handling and visualization, with average means of 3.45 and 3.38, respectively. The final areas where doctoral students perceived AI tools as beneficial in dissertation writing included drafting and editing as well as ameliorating research competencies. The qualitative findings further confirmed and were consistent with quantitative results, in which participants underscored the positive importance AI tools have on linguistic accuracy, brainstorming, and information retrieval. These findings perfectly matched those of Khalifa and Albadawy (2024), who asserted that AI improves academic writing across six domains: generating ideas, organizing content, synthesizing literature, handling data, refining drafts and ensuring ethical integrity.

The correlational analysis indicates a moderate positive and statistically significant relationship between AI use and CT skills among doctoral students. Regression analysis also attested to a strong predictive effect of AI tools on CT skills. However, this moderate correlation does not automatically prove causation. Accordingly, our findings are consistent with Jasmadi et al. (2024), who highlighted that AI use has a positive impact on CT skills, especially in areas of data analysis, problem-solving, and research decision-making. However, AI use is not the sole determinant; other factors such as prior academic experience and cognitive skills contribute to the development of CT skills. These finding parallels that of Teng and Al-Samarraie (2024), who concluded that while AI use promotes CT skills, it does not automatically lead to better cognitive outcomes.

Furthermore, the qualitative insights revealed that students who frequently used AI in writing are more likely to develop their analytical skills, since they need to constantly assess the reliability of AI-generated content. They further highlighted the importance of engaging critically with AI-generated outputs. This critical engagement stems from factual inaccuracies, flawed reasoning and fabricated or misleading information from GenAI models (Monteith et al., 2023), compelling students to approach AI outputs with skepticism, which may can foster deeper analytical skills. These perspectives are supported by several studies that recognized that AI use can positively impact CT. For instance, a study by Minh (2024) suggests that GenAI, such as ChatGPT, supports students' CT skills; however, it also emphasizes the need for thoughtful scrutiny of AI-generated content, which aligns with the qualitative results of this study.

As far as the limitations and drawbacks of using AI in dissertation writing are concerned, interviewees' responses are categorized into two groups: limitations associated with AI tools and the negative impact of AI use on doctoral students. The qualitative findings revealed limitations, namely plagiarism, limited access to data, and subjectivity and bias. This finding makes parallel with the one of Al-Sofi (2024), who concluded that there are concerns tied to the use of ChatGPT, such as plagiarism, insufficient references and the dissemination of incorrect information. Similarly, the findings of a study conducted by Rane et al. al (2024) show that ChatGPT has the potential of generating incorrect and misleading information, posing a threat to academic integrity and encouraging plagiarism (Chkarka & Fatmi, 2026). These issues raise ethical concerns about overreliance on AI in academic research, underscoring the critical need for AI literacy. As articulated by Long et al. (2023), educational programs aimed at AI literacy help build individual foundational knowledge and CT skills necessary for meaningful interaction with AI systems.

Regarding the drawbacks of AI use among doctoral students, they expressed that it can lead to heavy reliance on AI for daily tasks and weakened memory. Similar results were found in a study by Bai et al. (2023), which argues that frequent use of AI tools may lead to overreliance on AI, reducing CT and memory retention.

6. Conclusion and Implications

The main goal of this study was to examine the association between the use of AI tools and CT skills in dissertation writing among Moroccan doctoral students. The findings of the current study were supported by both quantitative and qualitative insights. The quantitative findings of this study shed light on the extent to which Moroccan doctoral students use AI in academic

writing, revealing that the vast majority of students use AI tools to review the literature, organize their writing, and analyze data, which enhanced their productivity. Moreover, the correlational analysis indicated a statistically significant positive relationship between AI use and CT skills, suggesting that students who use AI consistently tend to demonstrate a high level of CT in dissertation writing.

Further, qualitative data analysis revealed the perceived benefits of AI tools, as well as the limitations and drawbacks of excessive AI use. Participants reported improved linguistic accuracy, enhanced brainstorming, and improved information retrieval. However, expressed concerns regarding overdependence on AI-generated output can hinder students' intellectual discernment and weaken their memory. Not only that, but it is reported that AI-generated content can provide misleading information and can hold bias, due to its restricted access to data.

This study underscored both the potential benefits and the limitations of AI use in academic writing, especially regarding CT skills. Although the findings indicate that students who frequently use AI tools tend to score higher in CT skills, this does not necessarily guarantee cognitive development. According to these insights, this study offers several recommendations for writing instructors, educators, researchers, and curriculum designers. In practice, educators are called to incorporate and foster AI literacy in graduate, postgraduate, and doctoral training. The findings also call on policymakers and curriculum developers to strengthen the implementation of 21st-century skills, including CT, metacognition, and self-regulation. These skills can help students and researchers cope with challenges and capitalize on the benefits of these emerging technologies while avoiding their negative effects.

As for writing instructors, they can integrate these AI tools to train students and help them use these tools effectively to enrich their vocabulary, writing accuracy, and cohesion and coherence. Educators are also called to promote the ethical use of AI in various educational settings. Regarding research avenues, further studies are encouraged to cross-validate this study's findings.

This study is not without limitations. First, this study remains a cross-sectional examination of AI usage, which restricts the ability to observe changes in AI usage and their impact over time. Further qualitative, experimental, and longitudinal studies could provide deeper insights into the interactions among AI tools, writing, and CT skills. Other quantitative or mixed methods can take into account factors such as prior academic experience, engagement with AI tools, and students' cognitive abilities, which can play a role in enhancing or diminishing CT skills. Additionally, the use of self-reported data from questionnaires and interviews may have

introduced bias, as participants may have overestimated or misinterpreted their actual use of AI tools. Finally, the small sample size also limits the generalizability of the findings to broader populations of doctoral students.

Disclosure Statement

The authors declare that there is no conflict of interest regarding the publication of this article. No financial, personal, or professional relationships have influenced the research, analysis, or conclusions presented in this work.

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Appendix

Questionnaire: AI Tool Usage and Critical Thinking Skills in Dissertation Writing

Please answer the following questions honestly. Unless otherwise indicated, responses to Sections III and IV should be rated using the following 5-point Likert scale:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

Section I. Demographic Information

- Gender:

☐ Male ☐ Female

- Age: _____ years

- Doctoral Year

☐ 1st Year ☐ 2nd Year ☐ 3rd Year or Above

- Field of Study: _____

- University: _____

Section II. AI Tool Familiarity

- Do you use AI tools in your dissertation writing?

☐ Yes ☐ No

- Please indicate all AI tools that you use. (Check all that apply.)

☐ ChatGPT ☐ Gemini ☐ Grammarly

☐ QuillBot ☐ Mendeley ☐ Zotero

☐ Elicit ☐ Connected Papers ☐ Research Rabbit

☐ Other: _____

Section III. AI Tool Usage in Dissertation Writing

A. Literature Review and Research

No.	Item	1	2	3	4	5
1	I use AI tools for literature reviews.	☐	☐	☐	☐	☐
2	AI tools have facilitated the identification of research topics.	☐	☐	☐	☐	☐
3	AI tools have increased my efficiency in literature reviews.	☐	☐	☐	☐	☐
4	AI tools have helped me discover research relevant to my topic.	☐	☐	☐	☐	☐

B. Writing Structure

No.	Item	1	2	3	4	5
5	AI tools have improved the structure of my writing.	☐	☐	☐	☐	☐
6	AI tools help me paraphrase effectively.	☐	☐	☐	☐	☐
7	AI tools have helped me summarize research content.	☐	☐	☐	☐	☐
8	AI tools have reduced errors in my writing.	☐	☐	☐	☐	☐

C. Data Handling and Visualization

No.	Item	1	2	3	4	5
9	AI tools have made the data analysis process easier.	☐	☐	☐	☐	☐
10	AI tools have improved data visualization.	☐	☐	☐	☐	☐
11	AI tools have enhanced my ability to interpret statistical findings.	☐	☐	☐	☐	☐
12	AI tools have helped me present complex data effectively.	☐	☐	☐	☐	☐

D. Drafting and Editing

No.	Item	1	2	3	4	5
13	AI tools have sped up the initial drafting process.	☐	☐	☐	☐	☐
14	AI tools have reduced proofreading time.	☐	☐	☐	☐	☐
15	AI tools have reduced editing time.	☐	☐	☐	☐	☐
16	AI tools have improved the communication of my research.	☐	☐	☐	☐	☐

E. Creativity and Productivity

No.	Item	1	2	3	4	5
17	AI tools have enhanced my research creativity.	☐	☐	☐	☐	☐
18	AI tools have helped me produce more impactful research outcomes.	☐	☐	☐	☐	☐
19	AI tools have positively influenced my research decisions.	☐	☐	☐	☐	☐

Section IV. Critical Thinking Skills in Dissertation Writing

A. Remembering

No.	Item	1	2	3	4	5
20	I can easily recall key concepts relevant to my research.	☐	☐	☐	☐	☐
21	I can easily define important terms in my field.	☐	☐	☐	☐	☐
22	I can effectively summarize foundational theories related to my dissertation.	☐	☐	☐	☐	☐
23	I can recognize key researchers in my field.	☐	☐	☐	☐	☐

B. Understanding

No.	Item	1	2	3	4	5
24	I can explain the main concepts in my field.	☐	☐	☐	☐	☐
25	I can interpret complex research findings.	☐	☐	☐	☐	☐

26	I can summarize key concepts in my own words.	☐	☐	☐	☐	☐
27	I can paraphrase key ideas from academic sources.	☐	☐	☐	☐	☐

C. Applying

No.	Item	1	2	3	4	5
28	I can apply theoretical knowledge to my dissertation.	☐	☐	☐	☐	☐
29	I can use research methods effectively in my work.	☐	☐	☐	☐	☐
30	I can translate research findings into practical implications.	☐	☐	☐	☐	☐
31	I can relate my research findings to other findings in my field.	☐	☐	☐	☐	☐

D. Analyzing

No.	Item	1	2	3	4	5
32	I can critically evaluate different research approaches.	☐	☐	☐	☐	☐
33	I can draw meaningful insights from my research findings.	☐	☐	☐	☐	☐
34	I can break down complex problems into smaller components.	☐	☐	☐	☐	☐
35	I can categorize information to identify patterns and relationships.	☐	☐	☐	☐	☐

E. Evaluating

No.	Item	1	2	3	4	5
36	I can assess the credibility of research sources.	☐	☐	☐	☐	☐
37	I can defend my arguments with evidence.	☐	☐	☐	☐	☐
38	I can judge the significance of my research findings.	☐	☐	☐	☐	☐
39	I can critique existing research to identify its limitations.	☐	☐	☐	☐	☐

F. Creating

No.	Item	1	2	3	4	5
40	I can generate new research ideas.	☐	☐	☐	☐	☐
41	I can synthesize information from multiple sources.	☐	☐	☐	☐	☐
42	I can formulate original research questions.	☐	☐	☐	☐	☐
43	I can generate original hypotheses tailored to the focus of my study.	☐	☐	☐	☐	☐