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SUPERVISION OF DESIGN PHD STUDENTS IN AN ERA OF GENERATIVE ARTIFICIAL INTELLIGENCE

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ABSTRACT

Supervising a PhD candidate towards acquiring the requisite skills and competencies throughout their PhD journey is a fundamental aspect of PhD supervision. The emergence of various Generative Artificial Intelligence (GenAI) tools, such as ChatGPT, could be a potential paradigm shift for academic design research. Given the context, the consequences of the incorporation of GenAI in the supervision process need to be carefully explored to reap the benefits of such a modified approach in a transparent and ethical manner. This paper presents an exploratory study of PhD supervision activities influenced by GenAI, outlining the affected skills and competencies of PhD supervisors. The study involved conducting 11 semi-structured interviews with PhD supervisors from the engineering design community, which were subjected to a detailed analysis. Preliminary findings are presented, accompanied by a set of recommendations to navigate this emerging interface between GenAI and PhD supervision.

Keywords: Supervisor skills, PhD supervision, generative artificial intelligence

1 INTRODUCTION

Upon completion of their PhD study, PhD students should become autonomous researchers capable of independent research problem-solving and thinking. To do so, they should possess a wide range of skills and competencies to proficiently employ general research methods and tools for collecting, analysing, interpreting and communicating research data [1]. They must develop their abilities to propose novel insights and develop research contributions, aligned with the research methodologies utilised in their respective academic communities. Furthermore, they are expected to communicate their findings through scholarly papers and presentations proficiently. Throughout this PhD process, a PhD supervisor has a central role by being responsible for providing domain knowledge and expertise, guiding students through research/professional development initiatives and ensuring adherence to the highest ethical and quality standards [1].

The incorporation of Generative Artificial Intelligence (GenAI), such as ChatGPT [2], into research practices could potentially open a new dimension to PhD supervision (e.g. [3]), necessitating a re-evaluation of how supervisors guide their students through the complexities of PhD study within the engineering design context. In that sense, PhD supervisors should serve as role models by actively engaging in their professional growth [4] and leading the way towards well-educated and responsible integration of GenAI into design research practices. To do so, possibilities of GenAI as part of the research and PhD supervision process need to be carefully explored to better understand and reap the benefits of such a modified approach. Therefore, the primary objective of this paper is to conduct an exploratory investigation into the current effect of GenAI technologies on PhD supervision activities within the engineering design domain, with a particular emphasis on identifying the impacted skills and competencies of PhD supervisors.

2 RESEARCH METHODOLOGY

In the context of this exploratory research, we employ a qualitative methodology, centrally featuring interviews that will allow delving into the complexities of the influence of GenAI on PhD supervision within the context of engineering design research. A semi-structured interview was selected as a suitable

research method due to the exploratory nature of this study and the possibility of obtaining an in-depth understanding of the GenAI effect on PhD supervision with a limited number of participants.

The interviews covered key topics such as experience in PhD supervision, familiarity and use of GenAI tools in research, challenges and benefits, potential shifts in supervisory due to GenAI, necessary competencies for GenAI integration, and awareness of PhD students' GenAI usage.

The selection of interviewees was strategically made from the Design Society community, alongside the authors' direct professional networks. Precise inclusion criteria were set to ensure the relevance and depth of our data: only individuals with prior experience in supervising PhD students and who were actively overseeing PhD candidates at the time of the interview were considered. This approach resulted in a diverse group of participants, with academic ranks ranging from Assistant Professor to Full Professor. In total, we interviewed 11 scholars located in five countries: France, Sweden, Italy, Slovenia, and Croatia.

Given the rapid evolution of AI tools, we opted to conduct a series of interviews within a limited timeframe, aligning with the submission deadline for the full paper at this conference (March 11th, 2024). The duration of the semi-structured interviews varied, ranging from a minimum of 15 minutes to a maximum of 53 minutes.

The interviews were uniformly conducted in English via Microsoft Teams, recorded, and transcribed using Teams' automatic feature or Windows Stream when IT restrictions applied. Subsequent refinements were made to ensure the transcripts accurately mirrored the audio recordings.

The analysis of the results was conducted through reflexive thematic analysis [6], which allows the identification and interpretation of patterns within the collected qualitative data. This approach emphasises the integral role of the researcher's personal experiences and existing knowledge base, requiring a rigorous and introspective examination of the data [6]. Given that both authors are themselves experienced in PhD supervision, reflexive thematic analysis was deemed suitable for this study. The approach steps include, in a broader sense, familiarisation with the data, coding the data, and theme development [7].

3 RESULTS

The findings are organised around two central themes that were identified from the conducted interviews. To enrich the presentation of these results, selected quotations are directly extracted from the interview transcripts, providing tangible illustrations of the key points.

3.1 Effect of GenAI on different research activities

In general, the interviewees expressed many potential benefits of using GenAI for different research activities and discussed how these tools are used or could be used. Each interviewee had some level of experience experimenting with GenAI technologies; however, many indicated that their practical application of these tools across various research activities remained somewhat constrained. Their previous experience using GenAI allowed them to reflect on the related advantages and challenges, and they stated the need to spend more time testing and evaluating these tools to provide stronger claims. Interviewees identified several research activities for which GenAI could provide support.

3.1.1 Finding relevant papers and supporting literature review

Interviewees listed and commented on this activity among the first, indicating that they had several trials for this type of effort. They stated that GenAI (e.g. ChatGPT and associated tools such as Scholar AI) could be helpful in terms of conducting some preliminary checks of the research background (initial familiarisation with the topic) and searching for the most prominent work for a given research topic. In addition, AI tools could indicate connections between disciplines and different research viewpoints that were maybe not considered from the beginning (this can help with the formulation of research problem). Considering the interdisciplinary of engineering design, this ability is very important.

However, interviewees raised several concerns related to the balance between the comprehensiveness and depth of the literature review offered by these tools. A subset of interviewees cautioned against treating GenAI as a mere "search engine" and expressed their doubts regarding the quality of output for literature review, attributing their concerns to the quality of the sources employed in training the GenAI and the potential for "hallucinatory" content. Also, most respondents haven't used specialised AI tools

for literature review (e.g. Research Rabbit or Scite), and their claims are predominantly based on experiences with ChatGPT.

3.1.2 Summarising and synthesising

Summarising and synthesising findings from different research contributions was frequently highlighted during the interviews. As often mentioned by interviewees, a researcher has to provide the initial structure of the research idea, methodology, etc., in order to easily navigate the prompting process used as input for GenAI tools. The interviewees commented that researchers should still not over-rely on structuring suggested by GenAI tools, as achieving the desired outputs can be challenging. The current capabilities offered by GenAI allow for the summation of various research findings and speed up the process in that sense (*"It's quicker, it's faster, it gives us the extract, the essence of the papers."*). Additionally, one respondent suggested that these summaries could be perceived as a *"new blank page"* for e.g. literature review sections. To be more precise, this respondent believes that this allows the creation of the very first draft of this manuscript section.

Moreover, by inputting a range of documents and informational sources into GenAI tools, some interviewees reported the ability to extract key concepts from the document and gain initial insights for the following analysis. Still, the reliability of outputs remains an issue, and the underlying rationale for provided outputs is often hard to understand.

3.1.3 Analysing data and coding

Few interviewees pointed out that the emergence of these GenAI tools has democratised access to sophisticated data analytics capabilities, altering the way they approach data analysis. These tools have enabled a shift away from labour-intensive, manual programming tasks towards the automation of analytic processes through GenAI, streamlining their workflow.

Furthermore, GenAI tools are perceived as suitable for the rapid development of code, which is instrumental in creating software prototypes. Such prototypes play a crucial role in testing and validating various research contributions, a practice becoming increasingly prevalent in PhD studies within the engineering design research domain. While a certain level of knowledge is necessary to generate and repurpose the developed code, these tools offer substantial support to those who may not possess extensive expertise in computer science.

3.1.4 Improving research methodology

The opportunity to obtain early feedback from GenAI throughout the research process is perceived as the main strength by several interviewees. In this way, researchers can accelerate their learning curve and engage with GenAI in a collaborative manner, being challenged and questioned about the underlying rationale of different aspects of research methodology. For instance, one interviewee suggested asking for feedback on the preliminary design of experiments. The common perception is that GenAI often cannot offer detailed insights into every aspect of the research process, but it can trigger further reflections. However, these rapid feedback loops could be associated with agile ways of working in comparison to more conventional approaches based on the Design Research Methodology [8].

As an interesting use case of GenAI, two interviewees proposed generating datasets that could enable researchers to trial their methods and contributions prior to formal validation or application in real-world design contexts. This would allow pilot demonstrators in earlier research phases to obtain feedback and subsequently refine proposed contributions and/or approaches. Given the challenges often associated with acquiring data from industrial settings, GenAI can provide datasets that, while potentially not fully accurate or relevant, can still serve to validate preliminary concepts.

3.1.5 Writing activities

All interviewees reported prior utilisation of GenAI tools for a variety of administrative and routine tasks, demonstrating a comprehensive understanding of their potential to assist in generating textual content for diverse purposes. Specifically, for research activities, interviewees frequently acknowledged the support they got to enhance written communication.

GenAI tools strongly support activities such as translating, writing, proofreading, and editing, and this was recognised by all interviewees. This allows for a significant increase in writing quality (flow, readability), which is particularly beneficial for non-native English speakers in articulating their research findings more effectively.

3.2 Effect on PhD supervision

This section describes the main insights obtained from the interviews regarding the different aspects of supervising PhD students, considering these new emergent technologies.

3.2.1 Are supervisors familiar with GenAI practices of PhD students?

Half of the interviewees acknowledged a lack of close oversight regarding their PhD students' use of GenAI tools. Although they encourage students to use these tools and get familiarised with prompt engineering and GenAI skills, in general there is no specific supervision on this aspect of PhD study. Interviewees mentioned several reasons for this behaviour, such as the recent emergence of these tools (and lack of perceived need as it is still early), the desire to keep the same level of autonomy of PhD students, students' hesitation to use GenAI tools and prevailing supervision culture within certain academic institutions. Also, some interviewees admitted their own limited understanding of these tools, which hampers their ability to detect potential misuse. On the other hand, the impossibility of easily identifying improper use of GenAI was also highlighted as a concern (*"one of the difficulties is to check what was written by the students and what was written by the AI"*).

Two interviewees stated that they have high-level discussions with their PhD students about integrating and using GenAI in their research activities. Their practices involved some GenAI assignments, followed by a phase of experiential learning through trial and error (*"let them fail"*). In this way, students became familiar with the importance of precise prompting and current tool limitations. Afterwards, the following discussions were based on the generated output, fostering reflection on its quality and reliability.

In general, the observed lack of awareness and insights into the working routines of PhD students raises questions of trust and confidence (*"it has already changed everything in terms of confidence that a supervisor might have with his PhD student"*).

3.2.2 Upskilling of PhD supervisors

These emerging supervision issues indicate the necessity for upskilling supervisors to become familiar with these technologies, ensuring they can provide proper feedback on the generated outputs. All interviewees perceive the same necessity and are aware of a need to tailor their supervision practices. The common perception by interviewees is that the upskilling of supervisors should cover understanding the basic GenAI technologies and prompt engineering. Several interviewees acknowledged the need to start exploring these GenAI tools for research purposes. They expressed their willingness to learn more about their use and gain a deeper understanding of their reliability. This would allow them to evaluate the value and limitations of these technologies critically.

As the capabilities of these technologies evolve very fast, there was a comment by one interviewee that supervisors should be informed about the latest AI developments and understand their potential implications for research. Two interviewees pointed out that students might soon surpass their supervisors in knowledge of these tools, if they haven't already, indicating a pressing need to keep pace. Furthermore, one interviewee stated that it is crucial to learn how to measure and evaluate the quality of the GenAI output, while almost all of them referred to a need to educate themselves regarding the ethical use of these tools.

It is important to emphasise that one interviewee stated that higher education institutions should offer supplementary educational workshops for their faculty and staff, as opposed to relying on external private online courses on these teaching topics. Despite the absence of formal additional education among the interviewees, it is noteworthy that four of them supervise PhD students engaged in projects that explore the support provided by AI and GenAI in various engineering design tasks.

3.2.3 Will GenAI influence the ethical aspect of supervision?

As ethics and integrity are part of PhD programmes, all interviewees agree that these aspects should be carefully transferred to this GenAI usage context as well.

As one interviewee stated, *"the presence of AI tools in research projects does bring new dimensions to consider, such as data ethics, algorithmic transparency, and the interpretability of AI-generated results. These aspects should be part of the conversations with students. However, these discussions should be integrated into the broader context of research integrity and rigor, rather than prompting a fundamental change in supervisory approach."*

Interviewees agree that GenAI-produced output needs to be used responsibly for research activities, as PhD students are ethically responsible for their use of GenAI. However, as many institutions do not provide clear guidelines and regulations on the acceptable and proper use of GenAI, some interviewees are left uncertain about the best course of action.

3.2.4 Will GenAI change the PhD supervision?

The responses predominantly indicate the PhD supervisors think supervision will change, but they do not specify precisely how deep this change will be. However, some interviewees claim that change will be radical (*"I think that in PhDs there will be - before ChatGPT and after ChatGPT"*) due to the possibilities that these tools will offer, while others view this development as merely the addition of a new instrument to the existing toolkit (*"it's just adding a new tool"*).

In general, there is a consensus among the interviewees that the integration of GenAI tools should be encouraged but coupled with consistent scrutiny and critical evaluation of the quality of outputs. Most interviewees are not convinced that the impact of these technologies will be only positive, raising some major concerns such as overreliance on the generated outputs, losing sight of human-centric skills, a false impression of doing "thorough exploration", etc. Together with the aforementioned trust issues, most interviewees stated that institutional regulations and clear guidelines for the proper and ethically acceptable use of GenAI are necessary. Such measures would then allow the structured introduction of GenAI into PhD education, setting the boundaries for further use. However, a prerequisite for its introduction, as highlighted by interviewees, is the upskilling of PhD supervisors.

Even though interviewees believe that students and supervisors are together in this new emerging situation, opinions diverge on "leadership" roles (depending on the supervisor type [1]). Some interviewees advocate for supervisors to lead this endeavour, whereas others suggest that students might inherently possess a more intuitive grasp of these technologies.

4 DISCUSSIONS

The primary advantage of utilising GenAI tools lies in their capacity to speed up the discovery of pertinent literature, the extraction of its core concepts, and the acquisition of feedback. As such, these tools provide a basis for further improvement of technology-enabled supervision, potentially changing the interaction between supervisors and PhD students. To explore it, this study builds upon the previous work (e.g., [3]) and further extends it by exploring the perspectives of supervisors.

Before going into the specificities of the supervision process, interviewees expressed their doubts about the quality of outputs, and many of them were not aware of GenAI's potential for research. Still, there is a consensus among interviewees that these technologies should support the activities of PhD students. However, a PhD study requires considerable introspection and cognitive consolidation, or as one interviewee named it "internal maturity process", crucial for organising the knowledge acquired on the PhD topic. This should be reflected in a change of supervisory role and help them focus on the wider intellectual growth of PhD students, which cannot be replicated by GenAI tools [3]. Our findings suggest that GenAI tools hold the potential to support a reflexive approach to research activities [9], offering initial proposals that can serve as drafts for further validation and expansion by the PhD students. A "peer role" of GenAI is emphasised even more through the possibility of providing continuous and timely feedback. When appropriately utilised, GenAI can complement the supervisory role [1], addressing potential delays in feedback and contributing to a potentially more agile approach to PhD projects (in comparison to traditional approaches [8]). As such, the introduction of GenAI could enhance the efficiency of research projects and elevate the quality of written communication. This improvement should not aim to increase publication volume or shorten the duration of doctoral studies but rather to enhance the substance of the research output.

The obtained responses emphasise the role of critical thinking [10] even more throughout the whole PhD research process (problem formulation, literature review, definition of research methodology, data collection etc.), and a supervisor should carefully facilitate the development of related skills of PhD students. A supervisor should ensure that students fulfil the required PhD learning outcomes [1], irrespective of methods and tools employed during the PhD journey (which was perceived as a concern by interviewees). To do so, supervisors need to have enough knowledge of GenAI tools and prompt engineering (in addition to design domain expertise), to ensure that the outcomes derived from these tools are carefully developed and critically evaluated by the PhD students. Integrating GenAI could create a working environment where PhD students are empowered to concentrate on generating novel

ideas, validating them, and disseminating the results. Consequently, the role of the PhD supervisor may shift more towards reinforcing the foundations of research, such as source validation, critical thinking, methodological rigour, clarity of contributions, verification of new knowledge, and understanding the specificities of the design research community.

Emphasising an ethical approach, PhD supervisors should not solely depend on formal ethics education within the doctoral programme but should act as role models for responsible GenAI usage. These insights could inform the integration of GenAI into design research methodologies in a structured and systematic manner. By laying out individual research activities and related GenAI-support use cases, the role of supervisors extends beyond teaching PhD students to use them; they must also prepare them to master forthcoming GenAI tools that will soon become integral to the design research landscape.

5 CONCLUSIONS

The primary findings from this exploratory investigation indicate that the majority of interviewed PhD supervisors are primarily experimenting with GenAI tools like ChatGPT for personal/administrative rather than research-related applications. There is a notable lack of awareness among supervisors regarding their PhD students' use of GenAI tools and a significant gap in their understanding of specialised tools designed for research purposes.

Furthermore, findings suggest that, rather than seeking to prevent PhD students from utilising such tools, supervisors should equip them with the knowledge to utilise these new GenAI resources effectively and ethically. However, as a prerequisite, supervisors themselves must become familiar with the diverse functionalities offered by GenAI research tools and attain proficiency in their application. This knowledge is essential for critically assessing the outputs generated by these tools and ensuring their responsible and ethical utilisation in research. Moreover, findings highlight the critical importance of fostering analytical skills throughout the PhD journey, with supervisors playing a key role in guiding students to meet academic outcomes, underscoring the need for supervisors to encourage but critically assess the usage of GenAI technologies.

This exploratory study reinforces the pertinence of the topic at hand. A main insight is that the emergence of GenAI tools is compelling the research community to reassess the aspects of necessary PhD supervision and redefine the essential skills required of both PhD students and their supervisors. One of the future works will be to propose a dynamic list of GenAI tools efficient for research activities.

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