Generative AI Professional Development Needs for Teacher Educators

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Abstract

This study presents findings from a professional development (PD) webinar aimed at sensitizing and gathering teacher educators' knowledge of Generative Artificial Intelligence (GAI). The primary objective of the webinar was to deepen teacher educators' understanding and applications of GAI within the context of teacher education in Ghana and to identify areas requiring additional development. Three hundred and seven participants from a diverse group, including teacher educators, administrators, and in-service teachers participated in the PD session. The session was conducted online via Zoom. The video and audio recordings were transcribed and analyzed thematically using MAXQDA version 2022.4. Findings indicate a diverse range of familiarity with GAI among participants. While some expressed knowledge of GAI tools, others were learning about GAI for the first time. Further, the findings showed an increasing curiosity among participants for the inspiring functions of GAI in education, such as automatic scoring, academic writing, assisting teachers with image generation for their classroom practices, etc. The participants demonstrated a willingness to include GAI in their classroom practices and support their students. However, they also identified infrastructural gaps, such as the expense of premium GAI tools, training on GAI promptings, and ethical issues such as transparency, as potential barriers to the successful implementation of GAI in teacher education. Therefore, the study suggests that institutional support should be provided to teacher educators. This support would expand their access to various GAI tools and features. The study further recommends integrating GAI, including explainable GAI and prompt engineering, as a core component of teacher education and continuous professional development programs. Additionally, it emphasizes the importance of strengthening educators' skills in innovative assessment practices.

Keywords: *Generative Artificial Intelligence (GAI), Professional Development, Prompt Engineering, Teacher Education, Artificial Intelligence (AI), Assessment*

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1. INTRODUCTION

The emergence of GAI tools like ChatGPT and GPT-4 has reshaped various sectors, including education (Lim et al., 2023). Since the release of these GAI tools, there has been a plethora of concerns about their potential, especially in their applications in education (Zhai, 2023). As an emerging technology, there are many educators who have yet to experience GAI in education, especially in most developing countries like Ghana (Akanzire et al. 2023; Baidoo-Anu et al. 2023). Despite the potentials of GAI such as personalized learning and efficient knowledge transfer, educators are now faced with the challenge of integrating these advanced AI tools into their classroom practice (Kaplan-Rakowski et al., 2023; Liu et al., 2023).

Teacher educators are the professionals responsible for training student teachers for school systems at the tertiary level. As an open technology, it is assumed that student teachers may be exposed to GAI considering its open access and might be using it in an unethical manner in their academic work without awareness, particularly in their take-home assignments (Mogavi et al., 2023). To address this issue, it is crucial to highlight the importance of raising awareness of GAI among teacher educators, who hold the responsibility to support and educate student teachers to leverage GAI applications. This need is especially outstanding in places where digital literacy is still in the process of development, such as Ghana (Tounsi et al., 2023). Drawing upon this gap, we organized a webinar to sensitize teacher educators about GAI and to collect their insights, particularly in areas where they may seek assistance (Sancar et al., 2021; Koh et al., 2010).

Professional development sessions have been significant tools for teachers' engagement and professional learning in almost all levels of education (Avidov-Ungar, 2023), and so, this study reports the discussions from the professional development session organized to abreast teacher educators on the potential benefits and challenges of GAI, such as the ChatGPT and GPT-4. Based on these objectives, the following questions guided the study:

- What are Ghana teacher educators' perceptions and understanding of GAI applications in education after professional learning?

- What specific knowledge gaps do Ghana teacher educators need to enhance their GAI application?

2. DIFFUSION OF INNOVATIONS THEORY FOR GAI

The diffusion of innovations theory, formulated by Rogers in 1962, in conjunction with the technology acceptance model, lays the groundwork for understanding how new technologies and ideas permeate cultures (Smith et al., 2018). This theory, originating from the theory of reasoned action, predicts user attitudes, future intentions, and actual usage based on perceived usefulness and ease of use (Magsamen-Conrad & Dillon, 2020). Examining the incorporation of emerging technologies, such as GAI, into teacher education programs for teacher educators in Ghana, we found the diffusion of innovations theory became relevant to set a baseline for categorizing participants based on their inclination to embrace this novel technology on a spectrum from innovators to laggards (Magsamen-Conrad & Dillon, 2020).

Central to this theory is the "S-curve" depicting the adoption path: an initial slow uptake, a subsequent rapid adoption phase, and eventual stabilization. One of the key elements of this curve is perceived innovation attributes, such as relative advantage, compatibility, and complexity, which significantly dictate this diffusion. For instance, how the teacher educators in this study gauge the benefits of GAI compared to traditional teaching resources may be an essential element affecting their use of GAI (Dhirasasna & Sahin, 2021).

Again, factors like the ease of using GAI tools and observable results they produce play critical roles in shaping teacher educators' acceptance and subsequent integration into classroom practices (Stenberg, 2017). Therefore, determining the position of teacher educators on the adoption spectrum and identifying those factors influencing their perspective is critical. As posited by Kim et al. (2020), teacher educators' perspectives

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on technology adoption are essential in offering relevant recommendations for integrating GAI into teacher education programs (Zerfass et al., 2020).

3. FACTORS AFFECTING INNOVATION ACCEPTANCE

Teacher educators' perspective on the adoption, acceptance, and use of technology such as GAI is influenced by internal and external factors (Cerovski, 2016). Externally, factors such as flexibility of working with the GAI tools, provision of essential tools, the prospect of working with motivated students, availability of expertise in creating tech solutions, evaluating quality, teacher compensation, and funding play a role in the rate of adoption (Cerovski, 2016; Lawrence et al., 2018). Internal factors encompass learning anxiety, the inclination to interconnect, the acquisition of knowledge, and classroom interaction. Additionally, GAI adoption may be influenced by other internal factors like individual traits, which may include teacher educators' critical skills and complex problem-solving abilities (Alhumaid et al., 2023; Liang et al., 2021; Liu et al., 2021; Tyson & Sauers 2021). Eventually, it is highly assumed that these factors, whether internal or external, may have a great impact on teacher educators' perception towards the acceptance of GAI. This justifies the essence of continuous PD sessions to discuss the concerns and possible remedies. Research by Hung and Li (2017) highlights that most teachers possess a positive attitude towards professional development. This is because they perceive PD sessions as having a significant positive correlation with their capability to integrate innovation into their teaching (Ravhuhali et al., 2015).

4. METHOD

A qualitative research approach was adopted for this study. A recorded video from the PD session and a teacher survey were used as the tools for data collection. Heath et al. (2010) and Huber (2020) are of the view that video-based data collection is not only widely embraced in the academic research community but also commended for its potential to foster intimate interactions with research subjects. The PD session, which lasted almost two hours, was conducted as a webinar via Zoom for teacher educators in Ghana. Before the webinar, participants' demographic information was collected using a Google Form.

4.1 Participants

In total, 307 educators participated in the PD session. Though the study targeted teacher educators as the main participants, the participants included administrators in the field of education and teachers from Ghana's pre-tertiary education sector as well. The diverse nature of the participants ensured a multi-perspective dialogue informed by varying insights across the educational spectrum. The highest age brackets of the participants were 26-35 and 36-45 (see Figure 1).
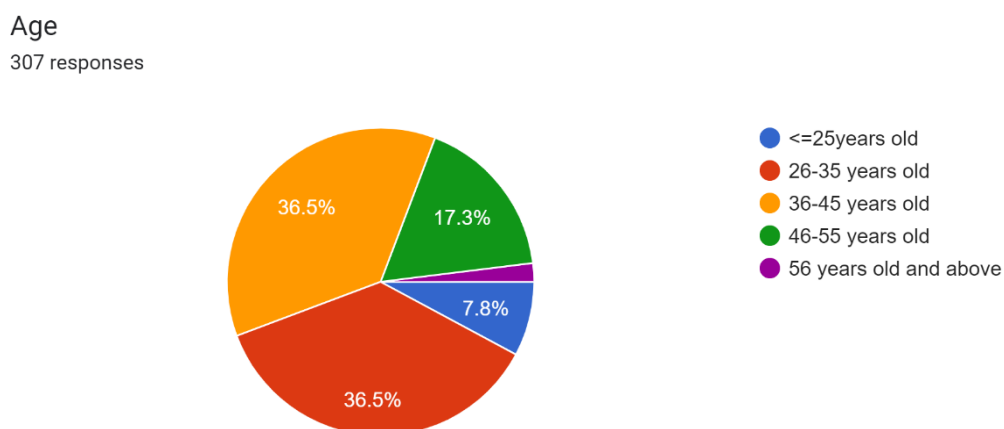

Figure 1. Age Brackets of Participants

According to Table 1, the colleges of education had the most representation of 121 representing 44.4%. Universities and polytechnics followed with 65 participants, representing 21.6%. The senior high schools and junior high schools had 36 participants representing 9.5%. Most of the participants were from the mathematics and ICT-related departments, with 106 participants representing 39.0%. The education department had 42 participants representing 12.5%. Twenty-four participants were from the technical and vocational, whiles 23 participants were from management and administration units. Twenty-one participants were categorized as 'specialized roles and others' represented 5.0% of the participants.

Table1. Frequency of Participant Demographics

Institutions	N (%)	Department and Units	N (%)	Designations	N (%)
Universities & Polytechnics	65 (21.6)	Mathematics and ICT-related	106 (39.0)	Teaching Roles	209 (79.8)
Colleges of Education	121 (44.4)	Science-related	43 (13.7)	Administrative Roles	41 (9.8)
Senior High Schools & Junior High Schools	36 (9.5)	Languages and Arts-related	48 (15.7)	Students & Academic Pursuits	29 (5.4)
Primary Schools & Basic Schools	25 (5.0	Education-related	42 (12.5)	Specialized Roles & Others	28 (5.0)
Other Institutions & Independent	60 (19.5)	Technical and Vocational	24 (5.8)		
		Management and Administration	23 (5.4)		
		Others	21 (7.9)		

4.2 Professional Development

The professional development was primarily initiated and organized through the collaborative efforts of the AI4STEM Education Center at the University of Georgina in the U.S., the Faculty of Education, University for Development Studies, Tamale in Ghana, the Gambaga College of Education in Ghana, and the Teacher Education Journal (TEJ), a wing of the National Teaching Council in Ghana. Together with these institutions, the TEJ led in the nationwide publicity of the webinar. During the PD session, the speaker delved into the definitions and applications of AI and Machine Learning (ML), emphasizing their capability to learn from experiences and make informed decisions through algorithms. He showcased Google Teachable Machine, illustrating how it enables the creation of ML models without necessitating coding skills while also highlighting its use in various sectors, such as disease diagnosis and refining teaching methodologies (Herdiska & Zhai, in press). He further led the discussion on using ML to assess student performance in science classes and shaping U.S. science education.

Also, he discussed how GAI has come as a game-changer yet with little empirical research done on its successful usage or threats in education (Zhai, 2023). The session discussed biases and pseudo biases of GAI and its essential components (Zhai & Krajcik, 2022), such as deviation from ground truth and systematic errors, and facial expression recognition errors. Examples were cited, such as the misclassification issues with Asian and black individuals, highlighting the limitations and potential pitfalls of AI algorithms.

4.3 Data Collection

Prior to the session, flyers with Google Form sign up links were distributed on various teacher educators' platforms in Ghana through their institutions and the Teacher Education Journal Newsletter. The registration process lasted for two weeks. Interested members filled out the Google form to provide some background information about themselves. The PD session was organized using Zoom. The features of Zoom were well managed to ensure there were smooth sessions without any external interruptions. The captions and record functions of Zoom were activated to enhance communication. The data saved from the session included video, audio, closed captions, and chat. These were used for the analysis.

4.4. Analysis

After the session, the video was transcribed and systematically analyzed using MAXQDA 2022.4. In support of the video transcripts, direct transcript from the Zoom recording was used to check for accuracies of the video transcripts. The thematic analysis was adopted for this study. The thematic analysis procedure mirrored the six phases of Clarke and Braun (2017) approach to thematic analysis. Therefore, the transcripts were initially coded by highlighting relevant sections with codes which represented specific ideas. These general initial codes were then grouped into potential themes. The themes were continuously reviewed and refined for coherence and consistency, ensuring they were representative of the data and aligned with the research questions. The analysis primarily concentrated on the participants' contributions, questions, and suggestions. This analysis helped to delve into the participants' perspectives, experiences, and views, distinct from the facilitator's (speaker of the webinars) presentation. To ensure the validity and reliability of the thematic analysis, the audit trail method and interrater of the transcripts were adopted. With these validity measures, documentation of the analysis process was maintained for transparency as well as a strict measure to capture the best accuracies through the Zoom transcripts and the Video transcripts from MAXQDA 2022.4. The demographic data collected from Google Forms were exported into Microsoft Excel and analyzed using frequency count and percentages. The demographic information was used to support the composition of the participants.

5. FINDINGS

The findings of the study stemmed from the research questions and the emerging themes from the transcripts as seen in Figure 2. Pseudo-names are used for direct quotes from the transcripts to support the findings.
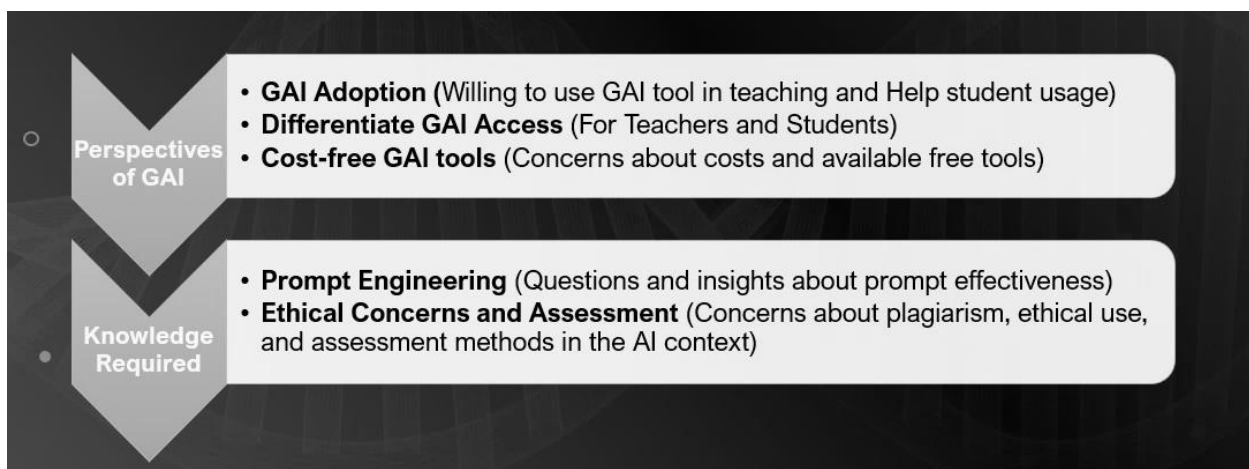

Figure 2. Teacher Educators Perspectives and Required Knowledge for GAI Application

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5.1 Perspectives of GAI

The analysis revealed themes capturing the views of participants about GAI. For some of the participants, the session served as their introduction to GAI's capabilities despite having prior knowledge of its existence.

5.1.1 GAI Adoption

Some participants found the session enlightening. They expressed admiration for GAI's potential and demonstrated a willingness to include GAI in their classroom practices, as they believed that embracing GAI in education could revolutionize tasks like scoring, visualizing lessons, research writing, and enhancing subject matter expertise. They also advocated for continuous professional development in line with GAI.

Participant 1: Thanks so much, Sir., for that great presentation. Please, Sir., we need special tools for the automatic scoring.

Participant 3: Thanks so much, Sir., for that insightful presentation. In this regard, I think the world should rather find ways and means of embracing the use of AI generally and ChatGPT in particular, in education, we should rather have the conversation learning on how best we can continue the use of ChatGPT and AI in general in education, inculcating into our curricula, so that we do not seem to be stifling progress as far as technology or invention is concerned.

Participant 2: I have a personal appeal to make to the National Teaching Council, Ghana, that they should try and encourage the use of AI in schools and keep teachers constantly updated so we don't become outdated.

Participant 4: GAI can help teachers to get images to be used in the classroom.

5.1.2 Differentiate GAI Access

The session had some participants suggesting different access to GAI tools between students and teachers. By this, they proposed teachers have exclusive features unavailable to students, which may potentially prevent situations where students might surpass their teachers in terms of derived content knowledge from GAI tools. However, there were other participants whose views were contrary to this suggestion. They suggested that students should be guided on the responsible use of GAI tools instead of differentiating access.

Participant 3: The tools that we are using over here, especially ChatGPT. Is there the possibility that students could be allowed to have some restrictions as to how they can use the tools? And teachers will rather be given the full opportunity to use all the features in their way so that it doesn't end up that the students are having an upper hand on the teachers rather?

Participant 6: The tools that we are using over here, especially ChatGPT. Is there the possibility that students could be allowed to have some restrictions as to how they can use the tools?

Participant 7: The students should rather be guided on how to effectively use AI rather than restricting their access.

Participant 8: Now that students have access to them; Tutors cannot restrict them.

5.1.3 Cost-free GAI tools

Also, some participants expressed interest in accessing a diverse range of GAI tools. However, they were interested in GAI tools that are available for free. The subscription costs associated with some GAI tools seem to pose a challenge for most of the participants. Presently, there are free versions of GAI tools, such as the ChatGPT, but the premium version requires users to pay for access. The GPT-4 is an advanced version of the ChatGPT free version and features significant improvements over ChatGPT in terms of the amount of data it

was trained on, its size, and its capabilities. These improvements include a better understanding of context, more nuanced language generation, and increased accuracy in producing relevant and coherent responses for teacher education. Most of the participants only had knowledge about the ChatGPT free version and were interested in learning about other free versions since they couldn't afford to subscribe to the premium version, GPT-4.

> Participant 9: Apart from ChatGPT, what other free AI tools are available for use in education? People try to find answers to this question on social media but almost all turn out to be paid AIs.

> Participant 10: Give us examples of GAI tools we in the developing world like Ghana can use to facilitate effective teaching and learning.

5.2 Knowledge Required

Participants were concerned about the ethical issues that come with the use of GAI among teachers. Additionally, they highlighted the importance of prompt engineering, emphasizing that the accuracy of GAI responses improves with better responses. Furthermore, they believe innovative assessment practices would be beneficial in curtailing academic dishonesty among students regarding GAI use.

5.2.1 Prompt Engineering

A section of the participants was curious about how they could prompt AI chatbots to improve the quality of the responses they receive from the chatbots. These questions stemmed from the few participants who were privy to ChatGPT at the time of the PD session. Additionally, some participants raised concerns about the inaccuracies in ChatGPT responses and wanted to know how they could prompt ChatGPT to get the most accurate responses.

> Participant 11: How does a teacher utilize prompting to improve their GAI responses?

> Participant 12: The quality of your prompts determines the quality of the response from ChatGPT.

5.2.2 Ethical Concerns and Assessment

One of the major concerns raised by participants was the ethical use of GAI tools and the skills required to assess their students in the era of AI. The issue of plagiarism was a particular concern, with participants wanting to know whether they needed to reference information retrieved from GAI tools and how to approach this. They also expressed worries about students using these tools for their assignments and project works and were eager to find ways to address these issues, especially since not all information provided by GAI tools is accurate and could be misleading. They sought to acquire the best practices, including innovative assessment, that would help them assist their students to use GAI tools effectively and ethically.

> Participant 13: We would like to know if there are known ethical issues with the use of AI in education.

> Participant 14: how do we assess our students to get them to achieve educational outcomes?

6. DISCUSSION AND CONCLUSIONS

GAI tools are still in their nascent phase, and the fact that most of the teacher educators lacked familiarity with these tools was unsurprising. This is particularly the case given that it was not until November 2022 that ChatGPT catalyzed widespread discussions around GAI tools (Thorp, 2023; Simhadri & Swamy, 2023). As an emerging technology, it is crucial for teacher educators to acquaint themselves with these tools, not only to integrate them into their teaching but also to assist their students effectively (Florida, 2023). The finding indicated the teacher educators' curiosity towards the capabilities of GAI, especially with functionalities like automatic scoring, aiding students in academic writing, and image generation for instructional purposes (Kaplan-Rakowski et al., 2023). These findings about the potential of GAI to revolutionize teacher education

align with the perceived usefulness element of the diffusion of innovation theory and the technology acceptance model (Smith et al., 2018). These models imply that technology or innovation will always be accepted once users find it useful in their practice.

Moreover, concerns about the potential misuse of GAI by students (Qadir, 2023) also support the prevailing belief about the challenges associated with technology diffusion, as outlined in the Diffusion of Innovations theory (Dhirasasna & Sahin, 2021). Consequently, these findings make it more prudent to equip teacher educators to adopt the best practices to effectively assist their students in using GAI tools. This finding supports Ng et al.'s (2023) assertion that teachers need AI competencies to integrate GAI effectively into classroom practices.

Additionally, prompting skill identified by the teacher educators as a significant skill resonates with Poola's (2023) assertion that crafting efficient prompts is vital in GAI usage and its outputs, given that GAI tools heavily depend on user input. This finding further confirms the perceived innovative attributes within the diffusion of innovation theory (Dhirasasna & Sahin, 2021), implying GAI compatibility of teacher educators' skills as an essential factor in the integration of GAI in their classroom practices (Dhirasasna & Sahin, 2021). Therefore, higher education institutions in Ghana, especially teacher education programs, must introduce courses or organize continuous professional development programs on prompt engineering (Meskó, 2023).

Moreover, the concerns about the costs of GAI tools may hinder teacher educators from gaining the best features of GAI tools. This is because most of the free GAI tools may lack the comprehensive features required for effective classroom integration (Whalen & Mouza, 2023). Hence, institutions are encouraged to incentivize premium versions of GAI tools and facilitate the integration of GAI in their programs (Brouwer et al., 2019).

Also, the findings suggest that many teacher educators lack a comprehensive understanding of GAI's operation, leading to less trust issues with its application (Gill et al., 2024; Samek & Müller, 2019). Therefore, efforts aimed at explaining the functions and mechanisms of GAI could substantially encourage its adoption among teacher educators. Explainable AI should be a core area in teacher education's continuous development programs about AI integration (Samek & Müller, 2019).

Assessment-related issues have consistently surfaced since the inception of GAI tools such as ChatGPT and GPT-4 (Zhai, 2022). Notably, certain studies, including those by Zhai (2022) and Zhai et al. (2023), have highlighted that GAI can outperform humans in tasks requiring substantial cognitive load, raising questions about its evaluation metrics and comparability to human capabilities. This aligns with the findings of this study, as the teacher educators were concerned about how GAI could potentially affect critical thinking and creative abilities among students. Therefore, the suggestion to adopt innovative assessment practices by the teacher aligned with Rudolph et al.'s (2023) findings, suggesting that GAI might decline traditional assessment practices at higher education levels.

In conclusion, the findings revealed an understanding of GAI by teacher educators and the essential knowledge they believe is crucial for the effective use of GAI. The finding indicated that teacher educators in Ghana are willing to include GAI in their classroom practices. They believe that embracing GAI could revolutionize tasks like scoring, visualizing lessons, research writing, and enhancing subject matter expertise. They further expressed their commitment to guiding students towards the effective and ethical use of GAI tools. However, the premium subscription costs associated with some GAI tools were seen as a challenge for several participants. Additionally, effective prompting engineering skills were identified by the teacher educators as one of the significant skills necessary for GAI application. They also called for innovative assessment practices to address the issue of academic dishonesty among students. Therefore, this study highlights the importance of institutional support in broadening the accessibility of GAI by addressing financial constraints that come with it, refining teacher educators' abilities through timely training; in prompt

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engineering and explainable AI courses whiles introducing innovative assessment practices. As GAI advances, it is crucial that teacher educators are adequately prepared to maximize the benefits of GAI in teacher education.

7. LIMITATIONS

While the study included 307 participants, the primary findings were predominantly derived from a subset of participants who actively engaged in the discussion session through questions, contributions, and clarifications. Therefore, researchers should be cautious to generalize the findings. Also, we suggest that future studies recruit a better representation of teachers to examine teacher educators' perceptions and understanding of GAI more comprehensively. Additionally, the duration of the session was limited, potentially restricting the depth and breadth of information that participants might have wanted to share.

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All authors contributed equally to the manuscript and read and approved the final version of this paper.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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