E-learning in Mathematics Education: Examining Teachers' Attitude, Intentions and Barriers

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Authors' contributions

This work was carried out in collaboration among all authors. All Authors designed the study, performed the thematic analysis, wrote the protocol, and wrote the first draft of the manuscript. They managed the analysis of the study. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aim: This study delves into e-learning in mathematics education, examining teachers' attitudes, intentions, and barriers in their teaching practices, specifically focusing on secondary school teachers in Laoang, Northern Samar.
Study Design: This study used a qualitative research approach, utilizing thematic analysis to examine the factors shaping mathematics teachers' attitudes and intentions toward adopting e-learning tools, along with the challenges they faced. By exploring the deeper reasons behind their experiences, the research provided valuable insights into what drives or obstructs the integration of e-learning in mathematics education.

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Place and Duration of Study: The study was conducted between February and April 2025 in Laoang, Northern Samar, focusing on mathematics teachers from Laoang National High School and Laoang National Technical High School.

Methodology: This study examines seven (7) mathematics teachers who were purposively selected based on their experience and willingness to adopt e-learning tools from Laoang National High School and Laoang National Technical High School. Semi-structured interviews and thematic analysis provided an in-depth understanding of their perspectives.

Results: finding reveals a complex interplay of enthusiasm and skepticism regarding e-learning integration. While teachers recognize its potential to enhance engagement and provide interactive learning experiences, concerns persist regarding accessibility, digital literacy, and the effectiveness of technology in teaching advanced mathematical concepts. The study identifies critical barriers, including inadequate technological infrastructure, limited digital literacy, misalignment between e-learning tools and curriculum goals, and institutional pressures driving a compliance-oriented approach.

Conclusion: Successful e-learning adoption requires a holistic strategy encompassing investments in technology, structured professional development, curriculum revisions to align with digital tools, and targeted initiatives to improve digital literacy among students and educators. Shifting from compliance-driven implementation to a blended learning model will foster more equitable and effective mathematics instruction.

1. INTRODUCTION

The rapid advancement of technology is reshaping education, particularly in mathematics, where interactive digital tools can transform abstract concepts into dynamic learning experiences. In response to the global shift toward electronic learning, accelerated by the COVID-19 pandemic, students now benefit from unprecedented access to educational resources (Das, 2021). Recognizing this shift, the Ministry of Electronics and Information Technology emphasizes online learning as a vital tool for effective instruction. The integration of technology in mathematics education enhances accessibility, efficiency, and engagement, enabling personalized learning experiences through interactive visuals and immediate feedback (Kiong, 2023; Hillmayr et al., 2020). By accommodating diverse learning styles, e-learning makes mathematical concepts more approachable and engaging, reinforcing its role as a fundamental teaching aid (Mailizar et al., 2021).

Despite its potential benefits, many math educators encounter significant challenges when adopting e-learning technologies (Ho et al., 2020). Their attitudes toward digital instruction vary widely, ranging from enthusiasm to resistance due to concerns about technological complexity and effectiveness. Key factors influencing e-learning adoption include perceived ease of use, usefulness, and institutional support (Kasa et al., 2024; Vladova et al., 2021). Additionally, barriers such as technical difficulties, inadequate training, and resource limitations can hinder successful integration. The digital divide further complicates implementation, raising concerns about equitable access to e-learning tools for all students (Almaiah et al., 2020). Understanding teachers' perspectives—attitudes, intentions, and obstacles—is essential for designing effective strategies to support them and improve e-learning integration in mathematics education (Khong et al., 2022).

E-learning adoption in mathematics is shaped by technological readiness, institutional support, and educator attitudes. Positive perceptions of its usefulness encourage implementation, while skepticism and discomfort with digital tools present obstacles (Ahmad et al., 2023). Studies employing the Technology Acceptance Model (TAM) highlight the influence of teacher experience and computer anxiety on adoption decisions (Siron et al., 2020; Sukendro et al., 2020). Nonetheless, challenges such as insufficient training and technical difficulties persist, reinforcing the need for structured professional development programs to enhance digital literacy (Kunwar et al., 2023).

The COVID-19 pandemic underscored the importance of virtual instruction, prompting institutions worldwide to expand their e-learning infrastructure (Rheddy et al., 2023). Research suggests aligning technology integration strategies with institutional objectives to maximize effectiveness and ensure sustainable adoption. While prospective educators show interest in ICT integration, they frequently encounter challenges, such as limited access to math-specific applications (Zamir et al., 2023). Previous studies emphasize the necessity of increased ICT resources to enhance educational engagement (Martin et al., 2021, 2024), while others explore barriers related to language and technology use (Jubran et al., 2023; Khan et al., 2023). Concerns over infrastructure limitations and digital literacy continue to hinder widespread adoption (Qashou et al., 2022; Liu et al., 2021).

To address these challenges, structured professional development and strategic investments in infrastructure are essential (Alenezi, 2023; Minea-Pic, 2020; Dumbuya, 2025). Digital tools must align with curriculum objectives to ensure meaningful integration in mathematics education (Chansa et al., 2024; Jaramillo & Chiappe, 2024). Policy-driven support, coupled with targeted digital literacy programs, can enhance student engagement (Soufghalem, 2024; Puniatmaja et al., 2024). Teacher training remains critical for successful implementation, fostering confidence and competence in digital education (Hamad et al., 2022; Moreno-Guerrero et al., 2020). Additionally, studies on pre-service math teachers highlight both the advantages and challenges of e-learning tools, emphasizing the need for user-friendly design and strategic application integration (Cabugwason et al., 2024; Nobis et al., 2024).

Furthermore, e-learning contributes to global education initiatives, aligning with the Sustainable Development Goals (SDGs). By promoting inclusive access and personalized instruction, it supports quality education (SDG 4), fosters innovation (SDG 9), reduces inequalities (SDG 10), and strengthens international collaboration (SDG 17). Effective partnerships among educators, policymakers, and technology developers can amplify the impact of e-learning and ensure its continued evolution as a powerful educational resource.

1.1 Research Questions

This study examined the factors that influenced mathematics teachers' adoption and use of e-learning tools, focusing on their attitudes, intentions, and the challenges associated with integration. Specifically, it aimed to answer the following questions:

1. How did mathematics teachers perceive the role of e-learning in their instructional practices?
2. What key factors shaped their intentions to integrate e-learning tools into classroom instruction?
3. What were the primary challenges that hindered the adoption of e-learning technologies in mathematics education?

2. METHODOLOGY

2.1 Research Design

This study employed a qualitative research approach with thematic analysis to explore the factors that influenced mathematics teachers' attitudes and intentions toward adopting e-learning tools, as well as the barriers they encountered. The qualitative methods used in this study were designed to uncover the underlying reasons behind teachers' experiences, making them well-suited for this research. By examining these factors, the study provided a comprehensive understanding of what facilitated or hindered the integration of e-learning tools in mathematics education.

2.2 Population and Sample

This study focused on mathematics teachers from two secondary schools: Laoang National High School and Laoang National Technical High School. A total of seven out of thirteen participants were selected based on their relevant experiences and demonstrated interest in adopting e-learning tools, while six individuals declined to participate in interviews. The study employed purposive sampling, selecting participants who could provide the most relevant insights. It specifically focused on mathematics teachers with prior experience or intentions to adopt e-learning tools and who were willing to participate with informed consent.

2.3 Research Instrument

This study aimed to examine the factors that influenced mathematics teachers' intentions to

adopt and utilize e-learning tools in their teaching. The researchers developed an interview guide consisting of carefully crafted questions to investigate the challenges mathematics teachers faced, as well as the strategies they employed to overcome obstacles and integrate e-learning tools. The interview guide was structured around expert-validated, open-ended questions addressing attitudes toward e-learning, factors affecting adoption, and barriers to implementation. Teachers were asked about their perceptions of e-learning's usefulness, its impact on student learning, and their confidence in using digital tools.

2.4 Data Collection

The researchers utilized a qualitative research approach to gather data. In-depth, semi-structured interviews were conducted with individual mathematics teachers using the interview guide, enabling meaningful discussions to capture their unique experiences with e-learning tools. The interviews were audio-recorded and transcribed verbatim for detailed analysis. This approach ensured that the researchers gathered comprehensive insights into teachers' attitudes toward e-learning, the factors influencing their intentions to use e-learning tools, and the perceived barriers to e-learning adoption in mathematics education. The qualitative data underwent thematic analysis to identify common patterns. This process ensured the reliability and validity of the findings while maintaining participants' privacy.

2.5 Data Analysis

The researchers applied qualitative techniques to examine mathematics teachers' attitudes, intentions, and barriers to e-learning in mathematics education. Thematic analysis was used to identify recurring patterns and themes, with data systematically coded and grouped for interpretation. Researchers familiarized themselves with transcripts, recorded observations, and refined themes based on similarities and relationships. To ensure trustworthiness, triangulation and member checking validated findings with participants. This approach helped identify challenges and strategies employed by teachers in adopting e-learning, providing valuable insights for improving teaching methods and support systems in mathematics education.

3. RESULTS AND DISCUSSION

3.1 Attitudes Towards E-Learning

Based on the data, teachers identified several key themes regarding their experiences with e learning adoption in mathematics education. These were categorized into the following themes: mixed feelings, perceived benefits, and concerns about effectiveness.

3.1.1 Cautious optimism

Many teachers acknowledged the potential of e-learning to enhance student engagement and make mathematical concepts more accessible. However, they also voiced reservations due to practical challenges such as unstable internet access, insufficient preparation time, and doubts about its effectiveness for complex topics. Research suggests that a gradual and well-supported approach to e-learning adoption is preferable, ensuring adequate training and realistic expectations. These findings align with studies by Hillmayr et al. (2020) and Rheddy et al. (2023), which emphasize the benefits of digital tools while recognizing barriers to implementation. Similarly, Karimi et al. (2023) and Cabugwason et al. (2024) underscore the need for incremental adoption strategies, given the concerns surrounding accessibility and digital literacy.

Here are some responses that reflect this theme:

> *"Great contribution to learning"*
> *"Highly effective"*
> *"Lack of stable internet"*
> *"Limited time for preparation"*

3.1.2 Skepticism regarding effectiveness

Many teachers expressed doubts about whether e-learning could truly support deep mathematical understanding, fearing that it might prioritize rote memorization over critical thinking. To address this concern, e-learning must be designed with interactive elements, collaborative learning opportunities, and well-structured curricula that foster higher-order thinking. Studies by Zamir et al. (2023) and Ray et al. (2020) highlight similar concerns, emphasizing the need for quality facilitators and effective digital tools to enhance conceptual learning. Ullah et al. (2023) and Cabugwason et al. (2024) also underscore that while digital math applications aid visualization, they sometimes lead to automation rather than

deep comprehension, reinforcing teachers' skepticism in this study.
Here are some responses that reflect this theme:

"Challenges like limited access to technology and over-reliance on automation"
"I'm having a hard time, especially with math."
"You think about whether it fits the lesson?"

3.1.3 Need for comprehensive support

Teachers emphasized that successful e-learning implementation requires comprehensive support, including training, resources, and institutional backing. Even motivated educators struggled with integration when lacking adequate preparation. Research highlights the importance of structured professional development, as noted by Minea-Pic (2020) and Dumbuya (2025), who stress the necessity of optimizing teacher education for effective digital tool utilization. Hamad et al. (2022) and Nobis (2021) reinforce the role of tailored training programs, particularly for mathematics teachers in the Philippines. Cabugwason et al. (2024) similarly assert that both pre-service and practicing teachers require structured learning opportunities to fully integrate e-learning into their instruction.

Here are some responses that reflect this theme:

"We are not exposed to e-learning tools."
"Limited in my knowledge when it comes to e-learning"
"Internet access and device availability can be barriers."

3.1.4 Pressure to comply vs. pedagogical choice

Some teachers felt compelled to use e-learning due to institutional mandates rather than personal conviction, creating tension between administrative requirements and pedagogical autonomy. Aligning institutional policies with meaningful educational objectives and granting teachers the flexibility to make pedagogical choices is essential to avoid a compliance-driven approach. Alenezi (2023) and Nobis et al. (2024) explore the restrictive nature of institutional directives on educators, emphasizing the need for balanced policies that prioritize student-centered learning. Qashou (2022) and Cabugwason et al. (2024) similarly highlight the importance of flexible e-learning strategies that accommodate teachers' instructional preferences rather than enforcing rigid adoption.

Here are some responses that reflect this theme:

"I wouldn't dare to use e-learning in my class...it is the demand of PMES...so we create PowerPoint"
"A necessity because we're in the digital age"
"I worry that if I don't use e-learning, I might get a lower rating."

3.1.5 Hope for enhanced engagement and outcomes

Despite challenges, teachers expressed optimism about e-learning's potential to enhance student engagement, improve learning outcomes, and diversify learning experiences. With the right support, they believed digital tools could transform mathematics education by making lessons more interactive and accessible. Hillmayr et al. (2020), Muangmee et al. (2021), and Evendi et al. (2022) highlight similar findings, emphasizing that well-designed e-learning systems can foster engagement and critical thinking skills. Cabugwason et al. (2024) also suggest that math applications can improve comprehension when strategically implemented, reinforcing the potential benefits identified in this study.

Here are some responses that reflect this theme:

"Significantly enhanced...engagement and understanding"
"It makes education more accessible, engaging, and efficient."
"E-learning tools have the potential to transform students' engagement."

3.2 Factors Influencing Intentions to Use E-Learning Tools

Participants identified three key barriers to e-learning adoption in mathematics education: access to technology, digital literacy, and teacher training. These challenges highlight the need for systemic improvements to ensure effective integration of e-learning tools.

3.2.1 Institutional pressure

Teachers emphasized that inadequate access to stable internet, reliable devices, and digital literacy skills hindered the adoption of e-learning tools, particularly in public schools. Financial constraints and infrastructure limitations disproportionately affect students, creating inequities in learning opportunities. Research by

Selwyn (2020) and Van Dijk (2023) underscores the necessity of investing in infrastructure and policies that ensure equitable access to technology. Similarly, Qashou (2022) and Cabugwason et al. (2024) highlight internet stability and resource availability as significant barriers, reinforcing the findings of this study.

Here are some responses that reflect this theme:

"I use e-learning because it's expected for our classroom observations and evaluations."
"Sometimes, I feel like I'm using it to check off a box rather than for real learning."
"I'm concerned that if I don't use e-learning, I might get a lower rating on my observations."

3.2.2 Teacher confidence and skills

Teachers observed varying levels of digital literacy among students, impacting their ability to utilize e-learning tools effectively. Many lacked fundamental skills in operating computers and mobile devices, hindering engagement with digital learning resources. Studies by Soufghalem (2024) and Puniatmaja et al. (2024) emphasize the importance of structured digital literacy programs, while Hamad et al. (2022) and Khan et al. (2023) highlight the role of accessibility in shaping e-learning adoption. Similarly, Cabugwason et al. (2024) found that app literacy directly influences both student and teacher engagement with digital tools.

Here are some responses that reflect this theme:

"I'm comfortable with basic things like PowerPoint, but I need more training for other tools."
"I need to feel confident that I can use the tools effectively before I introduce them to my students."
"I worry about making mistakes in front of my students when using new technology."

3.2.3 Curriculum integration

Educators consistently stressed the need for tailored training programs that address their specific needs in integrating e-learning into mathematics instruction. Without sufficient professional development, even motivated teachers struggle to incorporate digital tools effectively. Research by Moreno-Guerrero et al. (2020) and Dumbuya (2025) highlights the importance of optimizing teacher education for

digital learning environments. Nobis (2021) and Martin et al. (2021) similarly emphasize the need for increased ICT resources and structured digital literacy training for educators. Additionally, Cabugwason et al. (2024) reinforce the importance of specialized training to enhance e-learning adoption.

Here are some responses that reflect this theme:

"It's hard to find e-learning materials that fit our curriculum. We need better resources."
"If the curriculum doesn't support it, it's difficult to justify using e-learning tools."
"Maybe we need to change the curriculum itself to make e-learning a better fit."

3.2.4 Technological factors

Reliable internet access and appropriate technology are essential for successful e-learning; however, inconsistent connectivity and the digital divide remain major barriers. Many students lack access to devices, limiting their ability to engage effectively with e-learning tools. A balanced approach is necessary to integrate digital learning without excessive reliance on automation, ensuring that tools are engaging, user-friendly, and adaptable to classroom constraints. Studies by Selwyn (2020) and Van Dijk (2023) highlight the need for strategic investments in infrastructure to bridge the digital divide. Similarly, Qashou (2022) underscores how inadequate technological infrastructure hinders seamless e-learning adoption in higher education.

Here are some responses that reflect this theme:

"Need a reliable internet connection"
"Only a few students have cellphones."
"Over-reliance on automation"
"It was fun using it. But...doesn't have enough time"

3.2.5 Student-Related Factors

Students face challenges due to the digital divide, limiting their access to devices and stable internet, which creates disparities in learning opportunities. Teachers emphasized the necessity of designing e-learning tools that accommodate diverse learning styles while ensuring accessibility for all students. Addressing economic barriers by providing devices or selecting affordable tools is crucial for equitable e-learning implementation. Research by Almaiah

et al. (2020) and Rheddy et al. (2023) highlights how unequal access to technology affects students and teachers, reinforcing the importance of closing the gap. Habes et al. (2023) and Martin et al. (2024) further discuss the impact of technological inequities during remote learning, emphasizing the need for targeted support initiatives.

Here are some responses that reflect this theme:

> *"Only a few students have cellphones."*
> *"Student engagement, concept complexity, and accessibility"*

3.3 Perceived Barriers to E-Learning Adoption

Participants identified three key barriers to e-learning adoption in mathematics education: access to technology, digital literacy, and teacher training. These challenges highlight the need for systemic improvements to ensure effective integration of e-learning tools.

3.3.1 Access to technology

Teachers emphasized that inadequate access to stable internet, reliable devices, and digital literacy skills hindered the adoption of e-learning tools, particularly in public schools. Financial constraints and infrastructure limitations disproportionately affect students, creating inequities in learning opportunities. Research by Selwyn (2020) and Van Dijk (2023) underscores the necessity of investing in infrastructure and policies that ensure equitable access to technology. Similarly, Qashou (2022) and Cabugwason et al. (2024) highlight internet stability and resource availability as significant barriers, reinforcing the findings of this study.

Here are some responses that reflect this theme:

> *"The school's internet is often slow and unreliable. We need better infrastructure."*
> *"The lack of access to technology creates an unfair disadvantage for some students."*
> *"Many of my students don't have internet at home, and some don't even have a computer or phone."*

3.3.2 Digital literacy

Teachers observed varying levels of digital literacy among students, impacting their ability to utilize e-learning tools effectively. Many lacked fundamental skills in operating computers and mobile devices, hindering engagement with digital learning resources. Studies by Soufghalem (2024) and Puniatmaja et al. (2024) emphasize the importance of structured digital literacy programs, while Hamad et al. (2022) and Khan et al. (2023) highlight the role of accessibility in shaping e-learning adoption. Similarly, Cabugwason et al. (2024) found that app literacy directly influences both student and teacher engagement with digital tools.

Here are some responses that reflect this theme:

> *"Some students struggle with basic computer skills. They need more digital literacy training."*
> *"Before I can use e-learning tools, I need to make sure my students are comfortable with the technology."*

3.3.3 Teacher training

Educators consistently stressed the need for tailored training programs that address their specific needs in integrating e-learning into mathematics instruction. Without sufficient professional development, even motivated teachers struggle to incorporate digital tools effectively. Research by Moreno-Guerrero et al. (2020) and Dumbuya (2025) highlights the importance of optimizing teacher education for digital learning environments. Nobis (2021) and Martin et al. (2021) similarly emphasize the need for increased ICT resources and structured digital literacy training for educators. Additionally, Cabugwason et al. (2024) reinforce the importance of specialized training to enhance e-learning adoption.

Here are some responses that reflect this theme:

> *"We need more support and training in using specific e-learning tools effectively."*
> *"It's hard to keep up with the latest tech, and we need more professional development."*
> *"We need training that goes beyond the basics and helps us integrate e-learning into our lessons."*

3.3.4 Lack of resources and infrastructure

A significant barrier to e-learning adoption is the lack of adequate resources and reliable infrastructure, which extends beyond device availability to include connectivity issues and the quality of digital tools. Teachers emphasized that

outdated or insufficient equipment restricts the types of e-learning activities they can implement, while unreliable internet access disrupts lessons and hinders engagement. Addressing these disparities requires substantial investment in infrastructure and equitable access to technology. Studies by Qashou (2022), Rheddy et al. (2023), and Martin et al. (2021) underscore the importance of improving digital access to support e-learning adoption in educational settings.

Here are some responses that reflect this theme:

> *"We only have TVs, PowerPoint."*
> *"The school's internet is often slow and unreliable."*
> *"Only a few students have cellphones."*

3.3.5 Time constraints

Teachers reported that preparing e-learning materials is time-consuming, particularly for those managing multiple sections. The need to create engaging and effective digital lessons, combined with frequent technical difficulties, reduces the time available for focused teaching and planning. Streamlining e-learning preparation by providing efficient tools, ready-made resources, and structured workflows can help mitigate this challenge. Research by Ray et al. (2020) and Khasawneh & Khasawneh (2024) highlights the importance of simplifying e-learning integration to alleviate workload burdens.

Here are some responses that reflect this theme:

> *"At first, when you're new to e-learning, it's time-consuming."*
> *"I'm in seven classes."*
> *"Time is the problem here, time-consuming, and signal."*

3.3.6 Resistance to change

Some teachers expressed reluctance to adopt e-learning due to comfort with traditional teaching methods, concerns about technical difficulties, and uncertainties regarding student engagement. Overcoming this resistance requires fostering a supportive learning environment that builds confidence, provides mentorship, and highlights e-learning's role in enhancing rather than replacing traditional instruction. Studies by Hamad et al. (2022), Minea-Pic (2020), Yeo et al. (2022), and Ahmad et al. (2023) highlight similar

challenges in digital adoption, emphasizing the need for structured support and training programs.

Here are some responses that reflect this theme:

> *"I don't use it frequently."*
> *"Making mistakes in front of my student"*
> *"E-learning might create a disconnect."*

4. CONCLUSIONS AND RECOMMENDA-TIONS

This study explored the integration of e-learning tools in mathematics education among secondary school teachers in Laoang, Northern Samar, identifying both opportunities and challenges. While teachers acknowledged e-learning's potential to enhance engagement, they also raised concerns about accessibility, digital literacy, and its effectiveness in teaching complex concepts. Institutional pressures often led to a compliance-driven approach, limiting its true educational value.

Findings indicated that teacher attitudes toward e-learning require a balanced approach that includes careful curriculum design and interactive elements fostering critical thinking. The lack of comprehensive support systems negatively impacted teachers' confidence and ability to integrate e-learning effectively, highlighting the need for structured professional development programs.

Teachers' intentions to adopt e-learning were largely influenced by institutional mandates rather than pedagogical value, suggesting that policies should focus on meaningful integration. Training programs should prioritize digital literacy and curriculum alignment, ensuring that e-learning tools support learning objectives rather than merely fulfilling administrative requirements.

Overcoming technological, institutional, and pedagogical barriers is crucial for successful e-learning adoption. This requires investments in technology, professional development, curriculum revisions, and student-focused digital literacy programs. Blended learning approaches can address concerns about engagement and critical thinking while maintaining effective teacher-student interaction.

Collaboration between policymakers, educators, curriculum developers, and technology

specialists is vital to optimizing e-learning integration, ensuring it is transformative and beneficial for mathematics education. Let me know if you need further refinement.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

This research utilized Microsoft Copilot—advanced AI language models—for paraphrasing paragraphs and checking grammatical errors. Microsoft Copilot was employed as a tool to enhance the clarity and readability of the text, ensuring that ideas were effectively communicated while maintaining the original meaning. The use of these AI models contributed to refining the language and structure of the manuscript. Details of the AI usage are given below: Microsoft Copilot used for paraphrasing paragraphs to improve the clarity and readability of the text and for checking language and grammar to enhance overall accuracy and fluency.

ETHICAL APPROVAL AND CONSENT

The study adhered to strict ethical guidelines to ensure accuracy, trustworthiness, and respect for participants' rights. Written informed consent was obtained from all participants after providing full information about the study's purpose and procedures. Confidentiality was maintained by anonymizing identities and securely storing data, with participants having the right to withdraw at any time without consequences. Interviews were conducted with prior permission, and recorded data were used solely for research purposes before being destroyed to protect privacy. By following these ethical protocols, the study upheld research integrity while safeguarding participants' rights and confidentiality.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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