A Qualitative Study of Saudi Female Programming Lecturers' Attitudes towards Mobile Learning and Teaching Approaches

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Abstract
In Saudi Arabia, female students tend to struggle with the basics of computer programming, especially coding. To better understand why female students sometimes perform poorly in this discipline, this qualitative study aims to obtain the views of female computer programming teachers at a Saudi university on using mobile learning (m-learning) methods in computer programming lectures. Ten teachers from the all-female Aljouf University were interviewed to assess their perceptions of m-learning, in particular, the usefulness of ViLLE visualisation software. Data were analysed using thematic analysis. Most interview responses about m-learning and ViLLE were positive, although there were some notable negative responses. The Saudi culture-related responses were evenly divided between positive and negative, reflecting the culture's limitations.

Keywords:
Mobile learning, programming, lecturers' perceptions, female students.

1. Introduction

Researchers and educators are paying more attention to m-learning [1], which Traxler [2] defines as learning involving a mobile device. Although there are several practical m-learning approaches, further research is needed to discover whether m-learning is sustainable and can improve understanding of computer programming [3]. The growth of m-learning depends on its acceptance by lecturers and their views on using technology to enhance learning [4]. As lecturers play an important role in adopting successful m-learning and teaching approaches, it is necessary to understand their attitudes and the factors that could encourage or hinder technology adoption in the classroom [5]. This study explores female Saudi programming teachers' perceptions of using m-learning in programming lectures in terms of technology and the culture of social norms. Thus, this study is guided by the following question:

What is the perception of Saudi female programming lecturers towards using m-learning and teaching approaches?

The objective of this study is to understand programming lecturers' attitudes towards using mobile devices and the cultural implications of using mobile learning with female students. As a result of this study, understanding specific cultural views could create a framework for improving programming course delivery and educational outcomes using mobile devices.

2. Literature Review

M-learning can be understood as learning via multiple channels using mobile devices, such as tablets and phones [6]. The integration of m-learning in educational institutions has gained prominence in recent years due to its role in facilitating student–teacher collaboration both face-to-face and online. One of the major challenges institutions face regarding m-learning is that teachers' attitudes, perceptions and skills play a role in determining its success. In the context of Saudi Arabia, culture has traditionally denied female programming students the opportunity to interact and actively participate in programming classes. The conservativeness of Saudi universities towards mobile use was founded on worries about women's privacy and the abuse of cameras on mobile devices [7]. For example, female students have only recently been allowed to bring electronic devices into classrooms for learning. Generally, this limitation has compelled female students to rely on passively listening to lectures. This study aims to test the

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efficacy of m-learning approaches in delivering theoretical and practical programming lessons to Saudi female students through visualisation software. The gap in research on teachers' perceptions of m-learning in Saudi Arabia gives rise to an interesting research area, as students are enthusiastic about m-learning. Still, the perceptions of teachers have not widely been studied. Additionally, Saudi Arabia's culture can be a barrier limiting the widespread adoption of m-learning.

Universities in Saudi Arabia have incorporated m-learning in science, technology, engineering and mathematics (STEM) education, prompting research into students' perceptions and experiences with m-learning in Saudi Arabia [8]. Almutairy, Davies, and Dimitriadi [9] found that while m-learning in Saudi Arabia is still developing, students have a positive outlook on it and are keen to engage. Similarly, Nassuora [10] found that m-learning is still nascent in the country, though it receives eager student involvement. Alkhalaf, Amasha, and Al-Jarallah [6] also found that m-learning can play a crucial role in enhancing students' skills and knowledge and is an efficient way of teaching. In addition, researchers find that mobile-based techniques encourage active learning and student engagement. Thus, it can be used to enhance learning experiences [11]. However, Wurst, Smarkola and Gaffney [12] found a disadvantage when adopting mobile technologies during lectures, while Carlson [13] found that technologies distract students' attention.

Research on the perceptions and attitudes of teachers towards m-learning is limited. West [14] contends that teachers are pivotal in ensuring the success of m-learning and thus must embrace new technological advancements in education. Researching teachers' engagement with m-learning in the United Kingdom, Wishart [15] found that the use of mobile devices in education was still incomprehensible to teachers at the time, while a need for teacher training was also revealed.

The gap in research on teacher perceptions towards m-learning in Saudi Arabia gives rise to an interesting research area, as students are enthusiastic about m-learning. Still, the perceptions of teachers have not been studied widely. Given the rapidly evolving technologies and labour market demands for a technologically superior workforce, research in this area is critical, especially as Saudi Arabia is implementing massive plans for the enhancing its working population's skills to globally competitive levels through Vision 2030 [16]. Currently, there is a lack of research on the introduction of m-learning to female computer programming learners in the Saudi context. This gap was one of the motivational factors for this investigation.

3. Research Methodology and Data Collection

3.1 Data collection

The study was conducted at the School of Computer Science and Information Technology in the female colleges of Aljouf University in Saudi Arabia. Qualitative data were obtained from interviews with ten female programming teachers. The interviews followed a semi-structured format to help the interviewees feel at ease while remaining time-conscious. The intention was to limit each interview to one hour, although researchers could extend this period if the interviewee had additional insights they were willing to share. They often involve giving the list of questions to the participants beforehand so they can prepare their answers.

Conversely, semi-structured interviews allow for focus and flexibility within the topic [17,18]. Lecturers were invited to explore their attitudes towards modern technologies and their challenges in content adoption. They also tested the ViLLE visualisation tool to answer the main study question: What are female Saudi programming lecturers' perceptions of m-learning and teaching approaches?

3.2 ViLLE software tool

The ViLLE software website describes the tool as a visualisation learning tool developed by the University of Turku. Student and teacher versions are available. This tool can create and edit programming examples, allowing teachers to add them and visualise their execution in class or on the web. During program execution, the events in the program can be seen. The tool's primary use is to support the learning of beginner programmers. ViLLE can view programming examples in different languages so that basic similarities can be understood. New programming students need to understand how different programming concepts actually work rather than focus only on the syntactical issues of a specific language. This concept is called the programming language independency paradigm. To ensure

engagement, ViLLE provides many types of exercises combined with visualisations. There are multiple-choice questions, graphical array questions, general questions, graphical code line sorting exercises and, as a prototype, coding exercises to enhance the learning experience. ViLLE has been adapted for programming courses in many universities across the world. Research has shown ViLLE's effectiveness as a tool for improving the learning of novice students. Fig. 1 shows the ViLLE software tool on the screen where the teacher can create categories and exercises.

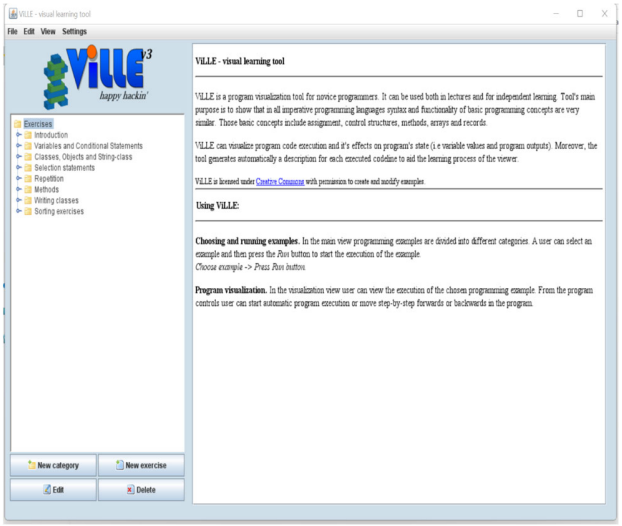

Fig. 1. ViLLE software tool

3.3 Data analysis

Individual interviews were conducted in the first semester of the academic year 2021, and researchers collected data exploring female computer science lecturers' intentions of using mobile devices in programming lectures. After each interview, the interviewer immediately noted the most important points from the conversations. All interviews were transcribed into the QSR NVivo 12 Plus data management program to identify themes related to teachers' stances and challenges of using mobile technologies in female computer programming lectures. Each transcript was independently analysed and verified to ensure the accuracy of each interviewee's responses. Themes were then identified based on detected phrases reflecting a generalisable topic. Sub-themes were determined through further analysis of variations within the themes, which are discussed in the following section.

4. Findings

The first group of findings is predicated on the stance of programming lecturers towards using mobile devices in the lecture and the features of the mobile learning approach. The second group of findings relate to the ViLLE software tool and the idea of this tool.

Participants' most frequent responses form the basis for identifying each theme. Fig. 2 shows four themes and sub-themes determined based on specific theories and concepts.

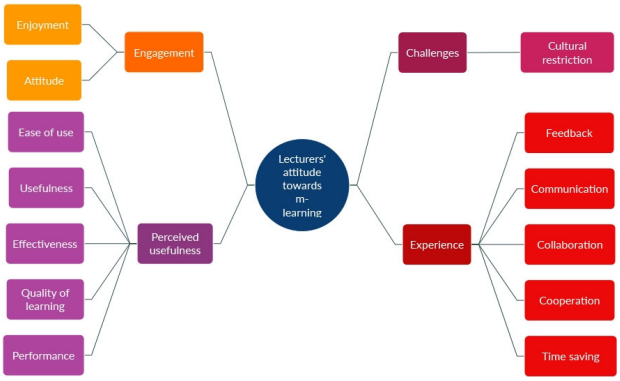

Fig. 2. Themes and sub-themes

The following four themes and sub-themes were determined based on certain theories and concepts:

1) **Engagement** (based on attitudes towards computer use [ATCU]), i.e., students' enjoyment of m-learning and lecturers' attitudes (positive or negative) towards m-learning.
2) **Experience** (based on constructivism and Chickering and Gamson's [19] seven principles of effective learning), including, feedback, communication, collaboration, cooperation and time-saving.
3) **Usefulness** (perceived usefulness of the technology acceptance model [TAM]), i.e., performance (whether the lecturers believe m-learning and teaching approaches will improve students' coding performance), quality of learning, effectiveness (whether m-learning enhances students' learning effectiveness), usefulness and ease of use.
4) **Challenges** (social norms), i.e., Saudi culture and implementation issues.

The participants were asked to give their opinions about ViLLE, a visual programming learning application that could be useful for teaching the basics of programming to novices. Their responses to five questions concerning the application were used to evaluate a trial of the ViLLE tool. The answers to these five questions fell under the following themes and sub-themes, which were more specific than the abovementioned themes:

1) **Engagement –** positive attitudes
2) **Experience** – feedback, collaboration and time-saving
3) **Perceived usefulness of the TAM** – performance, quality of learning, effectiveness, usefulness and ease of use
4) **Challenges** – cultural and implementation issues

4.1 Lecturers' attitudes towards m-learning and teaching approaches

The following four themes were discussed in relation to the lecturers' attitudes towards m-learning and teaching approaches.

4.1.1 Engagement

The first sub-theme of engagement was students' enjoyment of m-learning. Based on our thematic analysis, nine out of ten responses were positive. For anonymity, P is used to denote the participants. Participant 3 (P3) thought that students would enjoy m-learning because they had difficulty paying attention in traditional classes. According to P10, conventional lessons were boring for students. P1 and P2 added that learning by playing made the learning process more pleasurable. It was further mentioned that students were excited by m-learning (P6) and that the process was comfortable and enjoyable (P9). P7 responded negatively, stating, 'No, they do not enjoy using portable devices for educational purposes because students cannot stop surfing and following something else. Hardworking students, particularly, do not like this approach.' P5 disapproved of students using mobile devices, even if they enjoyed it, saying, 'Yes, but I do not think it is preferable because they [students] are distracted'.

The second sub-theme under engagement concerned teachers' attitudes towards ***students using*** mobile devices. As more than one response from the same participant was related to the theme, the responses outnumbered the participants. Of the responses, 13 were positive**,** and seven were negative. The positive responses ranged from short, 'I like the idea of the approach' (P1), to lengthy:

'I am excited that this approach is characterised by an average level of interaction between the students and teacher in the class. Yes, this approach should be implemented. I think what students learn on mobile devices can enhance the learning of programming because programming is a practical skill. Having them write programs in a lecture makes the whole learning process more interesting for them' *(P2)*.

There were other factors behind teachers' positive attitudes, including the capacity to 'quickly access information and find solutions to some programming issues' (P3), access 'portable devices'**,** and create a 'good environment suitable for the new generation' (P8) and teach a class of 'attentive and motivated students' (P6). P3 also stated that 'a mobile learning and teaching approach used for recreational purposes is more effective' and that 'online contests make students focus more on participation'. P10 thought that using mobile devices promoted easy interaction between students and teachers.

The following responses typified the seven negative attitudes:

'Lecturers find it difficult to apply the available mobile-based teaching and learning approaches in programming lessons because the use of mobiles distracts the students. Many of them will not focus on the teacher if the class requires the use of mobiles'. (P4)

'I do not like the current mobile-based teaching and learning approaches because some students do not make effective use of the devices. They play games and watch movies, which distracts them and other students. There are practical lessons (lab) that meet the purpose as the lecture environment is not suitable for programming'. (P7)

4.1.2 Experience

This theme is based on constructivism, which comprises seven principles of best practices in education that include encouraging student–faculty contact, developing student cooperation, using active learning techniques, giving prompt feedback, emphasising time on tasks, communicating high expectations and respecting diverse talents. This study assessed how constructivist elements facilitated the achievements of these practices. The experience

theme had five sub-themes: feedback, communication, collaboration, cooperation and time-saving. Only a few interviewees did not give responses relating to these themes, and the number of answers generally ranged from one to three. All of the responses were positive, and a few were particularly interesting:

- 'Online weekly meetings with some students will help teachers understand what students are going through and provide feedback on their programming level'. (P2)
- 'I think students need more feedback, and comments are an increasingly important feature, especially in the first year of learning programming'. (P3)
- 'This communication approach in a programming class enabled students to be more open to the material taught'. (P1)
- 'A mobile learning and teaching approach should encourage cooperation and teamwork in academic activities'. (P7)
- 'The mobile learning and teaching approach saves time and effort'. (P6)
- 'Mobile learning saves time as 'it reduces the students' effort and time spent searching for information and raises their awareness of the outputs of the programs being studied'. (P8)

4.1.3 Perceived usefulness

The TAM was developed by Davis, Bagozzi and Warshaw [20] as an extension of Ajzen's [21] theory of reasoned action. It identifies perceived usefulness and ease of use as factors influencing behavioural intention to accept and use technology. In this study, perceived usefulness was directly measured in terms of the sub-theme's performance, quality of learning, effectiveness, usefulness and ease of use. This perception is also affected by external factors. In this research, cultural factors determined whether Saudi females had access to computer education and, if so, to what extent.

One positive and one negative response regarding performance were received. P8 thought that using mobile devices when teaching programming provided flexibility, especially when checking students' scientific progress in programming in and out of lectures. However, P9 considered security issues to be a problem when using mobile technology:

'In using mobile teaching and learning approaches, security is an issue that concerns individual behaviour. Therefore, officials, staff, teachers and students must realise the importance of the proper use of these tools to enhance the chances of obtaining the desired educational outcomes'.

Three positive responses were obtained regarding learning quality, four regarding effectiveness and one regarding usefulness and ease of use. *Regarding* learning quality, P4 said, 'If it is to be applied, it should facilitate the learning and teaching process for both the student and the teacher and raise the quality of teaching programming'. P2's statement *addressed effectiveness*: 'Mobile learning and teaching in programming classes should be implemented. I think what students learn on mobile devices can enhance the learning of programming because programming is a practical skill'. Similarly, P10 also stressed effectiveness: 'Using mobile devices in programming classes should be effective, improving students' performance in programming, and flexible, allowing students to choose the teaching method they prefer. *Moreover*, these devices are convenient to use in lectures and make sharing opinions easy'. Only one response concerned usefulness and ease of use, with P1 commenting that if the technology *were* implemented in an organised manner, it would be *a handy* programming tool.

4.1.4 Challenges

The final theme concerned challenges, with the only sub-theme being the challenges arising from Saudi culture. This is a highly discussed topic in the literature, and it is not surprising that there were an equal number of positive and negative responses, with five each. P8 provided a typical positive response supporting female students in this respect:

'Now, everyone is aware of the use of portable devices everywhere, and I think the decision to allow the use of portable devices in girls' colleges in 2017 contributed to quickly overcoming the fear of photography and establishing a new cultural shift'.

P10 commented, 'Girls in Saudi Arabia now have camera devices everywhere and use them for entertainment. I think there is no longer any fear of being exploited by others'. P4 agreed and thought that the new cultural shift meant that girls no longer had any educational barriers. There were two notable negative responses, one from P3: 'The approach of using a mobile device in lectures is still considered a challenge for girls in Saudi Arabia, but the educational requirements in the modern era necessitate implementing this approach'. The other came from P5:

'The privacy of women in Saudi society still prevents us from using mobile learning technology on campus, and I am not comfortable with students using their devices in the classroom'. The remaining three negative answers were not directly related to mobile use but to general aspects of the Saudi Arabian culture.

4.2 ViLLE variables

The participants were asked to assess the program visualisation tool ViLLE and offer their impressions of a ViLLE app trial. Their responses were organised into themes and sub-themes, as previously outlined. Overall, 18 answers addressed teachers' attitudes towards ViLLE and its app, of which 12 were positive, and six were negative. P2 commented positively, '[The] ViLLE tool is excellent and useful for programming students'. P6 added, '[The] ViLLE tool is fine. It is better to utilise it solely in the classroom. It is good for self-education, helps students learn and gives them direct feedback'. Other typical positive replies were as follows:

- 'Yes, in general, any educational tool delivered via portable devices is useful, even if it lacks some features. I liked this ViLLE program because it gives students comments and feedback about their mistakes. I liked it because languages are important for learning the programming basics'. (P8)
- 'ViLLE is an innovative tool that ensures the continuity of the learning programming process and the acquisition of knowledge and skills from the beginning to the advanced stage, whether inside or outside the classroom. It makes learning easy by using a mobile device and allows interaction with others, which is good in general'. (P9)
- '[By using the] ViLLE application, I think that students make greater progress in programming when they use smart devices, as their motivation and love for everything technology facilitates their responses to lessons and establishes educational materials for them in the long run. It is fine, but there should be some new languages to keep up with the rapid development of software'. (P9).

There were also some negative attitudes towards the tool:

- 'ViLLE is only useful for beginners. For others, it is not apt because this type of program will only help programming students learn during their first semester'. (P1)
- 'ViLLE is not bad, but it cannot replace a teacher'. (P5)
- 'ViLLE is fine, but it lacks some features. Teachers cannot follow each student's progress unless they set a limit, which takes a lot of time'. (P8)

Positive responses were received for all three experience sub-themes. Four responses were given for feedback and one each for collaboration and time-saving. P1 provided a feedback-related response, stating, 'I like the ViLLE tool because it gives feedback regularly, which helps students understand the topic being studied and provides them with clear instructions on how to improve their learning'. Only P8 gave an answer linked to collaboration: 'Well, I like that the ViLLE tool enables students to collaborate. Collaboration keeps everyone engaged, whether through sharing or thinking. Even students who rarely, if ever, contribute can participate through it'. P1 also emphasised time-saving and noted, 'ViLLE may also save time and effort for both the teacher and the student'.

The perceived usefulness theme had four sub-themes: performance, quality of learning, effectiveness, usefulness and ease of use. Usefulness and ease of use drew the most responses, garnering a total of five. P3 thought that the ViLLE tool was useful in improving cooperation and interaction between students, as it enhanced their learning efficacy and enthusiasm for learning through the online quizzes. Two positive and two negative responses were given regarding performance. P1 said, '[The] ViLLE tool will contribute to improving students' programming performance as they learn enjoyably. It attracts them to continue learning without getting bored'. However, P6 responded, 'If students lack [the] programming basics, they cannot perform through the ViLLE app. The student must initially learn from the teacher through traditional paper assessments'.

Quality of learning had one positive and one negative response. P3 answered favourably, stating, 'I like the ViLLE tool because it is an amazing opportunity, and I think that using mobile phones inside the classroom improves education quality'. In contrast, P7 said, 'I prefer the paper test as students may easily cheat, search for information and answer questions. Thus, the neglectful student cannot be distinguished from the hardworking one in the case of

the ViLLE tool'. All three responses for effectiveness were positive. P7's remark best expressed the positive sentiments: 'ViLLE is an important language to teach programming introduction and helps the student gradually learn professionalism'.

Regarding implementation, two participants raised issues, while six others were positive. P7 simply did not like the tool, as they generally did not like using mobile devices in lectures. P2 identified a more serious concern: 'Before implementing this approach, we must raise awareness of the importance of proper laptop use. I have encountered female students who used recordings to blackmail their teachers, which is unacceptable in our culture'. Nevertheless, P3 commented positively, 'I believe that if we move beyond the negative perception of using a mobile device in the classroom, students' ability to understand the concepts being taught will increase, and teacher productivity will increase in turn'.

5. Discussion

This study involved evaluating the attitudes of Saudi female computer science lecturers' towards helping female students learn computer programming using mobile technology in lectures. The research question was:

What is the perception of Saudi female programming lecturers towards using m-learning and teaching approaches?

Following an investigation into programming lecturers' experiences of using mobile devices to aid teaching, our findings show that most of them support using mobile devices as a delivery method because it results in a more effective and engaging learning environment for students. These perceptions align with our research's focus on encouraging Saudi female programming students to utilise mobile devices as learning aids in classrooms and demonstrate that culture is no longer a barrier to adopting such an approach.

Additionally, the engagement factor provides students with a fun environment that attracts and motivates lecturers to accept the use of m-learning [22]. As a result, enjoyment must be considered when designing and incorporating technologies for programming courses. Eight of the ten lecturers interviewed asserted that a mobile-based teaching and learning approach in programming classes could enhance students' enjoyment of their lectures and learning attitudes. Lecturers voiced primarily positive attitudes towards using mobile devices when teaching programming, as did students [23,24], who believe they increase levels of interest and enjoyment [25]. The increased satisfaction when delivering programming courses using mobile devices validates the importance of adopting such an approach.

According to lecturers, the ability to provide student feedback, save time and collaborate are among the advantages of using mobile devices to deliver learning, the former being the most pertinent [26]. Feedback aids in determining the advantages and disadvantages of students' instruction [27]. Lecturers' attitudes towards the ViLLE visualisation software are primarily positive because it provides feedback on their exercises. As a result, it is important to use software tools that provide teachers with a channel for feedback to comment on students' work [28] and motivate students to pay more attention to lecturers. Such a feedback channel could improve the quality of students' educational experiences.

Saving time is another crucial factor to consider when examining the effective use of mobile devices in programming courses. In terms of the ViLLE learning tool saving students and lecturers time, lecturers stated that it could help students complete their tasks within the allotted time and improve their knowledge of the programs they are learning.

Moreover, lecturers are increasingly implementing student collaboration through mobile devices [29,30] or other similar tools. They believe that some software enables students to collaborate. For example, most students input answers faster via ViLLE than the same group using pen and paper because the questions and answers were fully visible in ViLLE but appeared on separate sheets of paper in the conventional method [31].

The Phase 1 results show that perceived usefulness positively and significantly influences lecturers' views of mobile device use and the ViLLE tool, which is consistent with the findings of [32,33], who discovered that perceived usefulness influences acceptance of mobile use. It combines performance, learning quality, effectiveness, usefulness and ease of use, resulting in technology adoption [34]. Numerous studies support the effectiveness of mobile visualisation tools [35,36]. According to our data, most programming lecturers found the ViLLE visualisation software beneficial to students' learning performance and quality.

Culture should not be a barrier in the Saudi programming learning environment, given that lecturers noted a recent cultural shift evidenced by students now knowing how to use mobile devices. Therefore, m-learning and teaching can be freely used in these courses. Some conservative Saudi female programming teachers' negative attitudes towards students' misuse of mobile devices with cameras will negatively impact the adoption of m-learning in classrooms. Almarwani [37] and Al-Shehri [38] identified traditional cultural norms as significant barriers to m-learning in Saudi tertiary education. However, they could not adequately explain how the cultural norms impacted teachers' and learners' adoption of m-learning.

6. Conclusions

This study aims to investigate the effectiveness of mobile learning methods in delivering programming courses using mobile-based applications of visualisation tools. The results showed lecturers' high level of readiness and acceptance by female computer programming students to use mobile devices and visualisation tools, thus defying the cultural barriers against female students in Saudi Arabia. We believe that our study makes a significant contribution to the literature because it involved the evaluation of Saudi female computer science lecturers' attitudes on how to help female students to learn computer programming courses using mobile technology in programming lectures, identifying four factors: engagement based on attitude towards computer use, experience based on constructivism in mobile learning approach, perceived usefulness, and challenges from the Saudi social norms necessitating a cultural shift for female programming students towards using mobile devices in lectures in Saudi Arabia.

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Conflicts of Interest: The authors declare no conflicts of interest.

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