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Digital Transformation in Education: Leveraging Technology for Enhanced Learning Experiences

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Abstract: Digitalization is an important innovative approach to the development of the entire education system. The Covid-19 pandemic has significantly intensified it, and now, despite all the global challenges, it continues to develop actively. Therefore, this problem is relevant and requires a thorough study of the peculiarities of introducing digital technologies into the education system. Therefore, the purpose of the paper is to study the digital transformation of education through the prism of analyzing innovative technologies that contribute to its development. A quantitative research approach was used for this purpose. The participants of this study are 211 teachers and students from different educational institutions. The selection procedure was purposeful and based on several inclusion criteria, including experience in using technology. The main tools for the study were questionnaires and focus group interviews. Data processing was carried out in stages with the appropriate use of scientific methods of knowledge: content analysis, cluster analysis, factor analysis, and comparison method. The results of the study demonstrated the wide awareness of modern teachers and students of innovative tools. Based on the interviews, it was determined that the use of digital technologies in the learning environment has a number of advantages, including the speed of providing initial information, flexibility and accessibility. It is established that the use of digital technologies in education improves students' perception, increases the level of motivation and interest in learning. The conclusions summarize the main opportunities for the development of the digital education system and characterize potential ways to improve it. In particular, it is established that important issues that need to be addressed are ensuring a safe learning cyber environment, improving the material and technical base, and further developing the digital literacy of teachers.

Keywords: change of educational paradigms, innovative technologies, digitalization, optimization of learning, survey.

Introduction

Digitalization is a current trend that is affecting the entire education system, which has undergone a radical transformation. Nowadays, it is possible to obtain knowledge from any access point; the only important condition is the availability of the Internet. The very concept of “digitalization of education” is broad in scope and content and involves the introduction of various digital technologies into the educational process. A modern digital educational institution is an educational institution that has been radically transformed in terms of its structure, management approaches, and research system. Modern researchers have proven that digitalization is an important approach that is actively used in modern educational institutions around the world. In particular, Bayne & Gallagher (2021) describe the practical aspects of digital education implementation. According to Brown (2018), it is now impossible to imagine a modern university without the digitalization of the educational and administrative space. The main information technologies that contribute to the stable innovative development of the educational sector are analyzed in detail in the study by Dumbiri & Permana (2021). In addition, Bobro (2023) described the role of artificial intelligence in improving educational attainment. However, modern scholars also determine that the implementation of digital technologies in education has both a number of advantages and disadvantages. Sari & Nayır (2020) highlighted the main difficulties in introducing digital technologies into the education system. Thus, there are different approaches to the study of the digitalization of education in scientific thought.

Research Problem

A brief analysis of recent studies shows that digitalization has both positive and negative impacts on the development of the education system. It is obvious that not all educational institutions have ample opportunities to introduce innovative technologies into the learning environment. Although this problem has been raised in detail in recent studies, contemporary authors, unfortunately, do not focus on the attitude of students to active digitalization. At the same time, the focus should be on assessing the use of modern technologies in the education system. In particular, it is necessary to identify those

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technologies that contribute to the enrichment and efficiency of education, which will be one of the subjects of this study.

Research Focus

The main focus of this study will be on the assessment of teachers and students regarding the use of modern digital technologies in the educational system. Based on this assessment, the effectiveness of involving certain digital and information and communication technologies in the educational process will be determined. Separately, the study is focused on analyzing the role of digitalization in the system of improving the quality of knowledge acquisition.

Research Aim and Research Questions

Thus, the purpose of this paper is to characterize the digital transformation of education against the background of analyzing the use of digital technologies. With this goal in mind, the authors of the article have identified important tasks for its implementation:

1. To assess the introduction of digital technologies in modern education based on a survey;
2. To characterize the key technologies that contributes to the enrichment of the educational system;
3. Identify the main opportunities of modern technologies to improve education.

Literature Review

The problem of digitalization of education is actively in the field of research interests of modern scientists. Some researchers note that the development of digital skills and competencies remains an important unresolved issue (Gabriel et al., 2022; Tursunalievich & Rahmat, 2021). This problem develops sporadically and often separately from academic (i.e., formal) education, and therefore, a promising direction for modern educational institutions is to improve teachers' skills in digital literacy, based not only on course development but also on the use of digital learning environments (Prinsloo, 2019).

Modern qualitative studies also describe the main tasks of digitalization that higher education institutions should address, focusing on the need to develop the digital literacy of teaching staff (Rossikhin et al., 2020). The critical work of Decuypere, Grimaldi and Landri (2021) describe the problem of introducing modern digital platforms into the learning space. The authors note that they are important elements of quality digital education. At the same time, according to Dogan, Goru Dogan and Bozkurt (2023), an important component of innovative online education is the use of artificial intelligence systems that improve learning by making it more accessible and of higher quality. In particular, artificial intelligence can quickly analyze large amounts of data, which is important when monitoring and evaluating student performance, as described in detail in Lee (2020). Also, according to Bobro (2024), artificial intelligence technologies are important for the formation of an effective digital space. At the same time, Irons and Crick (2022) characterized the issue of cybersecurity in the modern educational space. The authors identified the main components of a secure online learning environment. Also, Mozgalli, Rybalko and Synytskyi (2019) identified the importance of forming a peak-free information environment for modern students. Munir, Vogel and Jacobsson (2022) characterized the main modern approaches to learning. The authors determined that machine learning and the use of artificial intelligence remain important current trends. Qureshi, Khan, Raza, Imran and Ismail (2021), based on a critical systematic literature review, characterized the advantages and disadvantages of using digital technologies in the Education 4.0 system.

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Current researchers also focus on the problem of creating publicly available digital educational resources to achieve the goals of general education institutions, as well as the problem of developing and using national programs (Reid, 2020). Modern scientific works also highlight the current issues of using digital technologies for distance learning in the context of the COVID-19 pandemic and the difficulties associated with the war (Shearer et al., 2019, Williams et al., 2023). Perraton (2020) also characterized the theoretical aspects of studying distance, remote and online learning. Empirical studies have made it possible to identify the needs that arise when organizing distance learning. The responses described in the research by Shearer et al. (2019) serve as an important basis for formulating recommendations to national authorities to improve the digitalization of education. At the same time, according to White, Yang, Muñoz and Gao (2023), it is important to develop the digital competence of teachers and improve the basic conditions for organizing online communication. With regard to the problem of transferring educational services to the online environment, scholars emphasize the prospects of this format of knowledge acquisition in general. At the same time, this problem is not exhaustive and requires a more detailed study of the peculiarities of digitization of the education system based on experiments.

Materials and Methods

Realization of the research objective required a quantitative approach to the study. Based on the processing of quantitative data obtained from the survey and interviews, this study comprehensively outlined the key components of digitalization in the educational system and determined their effectiveness.

Sample and Participants

The study involved 211 teachers (87) and students (124) to determine the role of digitalization in the education system. The participants had different ages and teaching experience (see Table 1).

Table 1

Demographic data of teachers

Demographic data	% of the total number of teachers
Gender	Female: 75% of teachers Male: 25% of teachers
Age	20-29: 6% of teachers 30-39: 28% of teachers 40-49: 34%of teachers 50-59: 23% of teachers 60 and above: 9% of teachers
Experience	1-4 years: 6% of teachers 5-10 years: 23% of teachers 10-20 years: 34% of teachers 21-30 years: 20% of teachers 30+ years: 17%of teachers

Source: Author's development

The demographic data of the students is also diverse: students from different fields and specializations were involved. Students with different educational levels also took part in the study.

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Table 2

Demographic data of students

Demographic data	% of the total number of students
Gender	Female: 50% of students Male: 50% of students
Age	18-20: 36% of students 21-25: 48% of students 26+: 16% of students
Specialization	Natural sciences: 24% of students Humanities: 32% of students Technical disciplines: 24% of students Art: 20% of students
Education	Bachelor: 56% Master: 40% Phd students: 4%

Source: Author's development

The criteria for inclusion were based on familiarity with educational digital technologies, understanding of basic digital tools, and experience in using digital technologies.

Participant inclusion criteria:

1. Familiarity with modern educational digital technologies
2. Understanding of the main digital tools used in education
3. Experience in using digital technologies: teachers should be proficient in these technologies
4. Participation in the study of participants from different regions in order to comprehensively approach the research problem

In addition, the procedure for selecting participants was based on a targeted system: invitations to participate in the survey were sent out via social networks and e-mails: all interested students and teachers could take part in the survey.

Instruments and Procedures

The main research tools were a questionnaire and focus group interviews. The research questionnaire was designed to cover important issues related to the digitalization of the education system that would concern both students and teachers. It consisted of several paragraphs. The first one was devoted to analyzing the demographics of the participants, while the rest dealt with specific issues of using digital technologies in the learning process:

1. How often do you use digital technologies to acquire knowledge or organize your learning environment?
2. 2. What specific technologies do you or your teachers mainly use when organizing learning?
3. 3. What communication channels do you use in your digital education system?
4. Does the use of technology affect the development of students' motivation to learn (for teachers only)?
5. How do you generally assess the effectiveness of digital technologies in the education system?

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Zoom interviews in smaller focus groups (up to 30 people) were conducted to identify the main advantages and disadvantages of using digital technologies in the education system. All the views of the participants covered in this webinar were taken into account. The main questions were:

6. Specify the main advantages of using digital technologies
7. Describe the challenges to using these technologies
8. Provide additional comments on digital technologies in modern education
9. In general, how can you assess the effective or ineffective use of digital technologies in education?

Thus, the main focus of the interviews was on the personal experience of using digital technologies by the participants of the experiment, finding out their attitude to the digitalization of education in general.

Data Analysis

The data obtained from the questionnaire and interviews were processed in stages with the appropriate use of scientific methods of cognition. Therefore, the study used content analysis, cluster analysis, factor analysis, and the method of comparison.

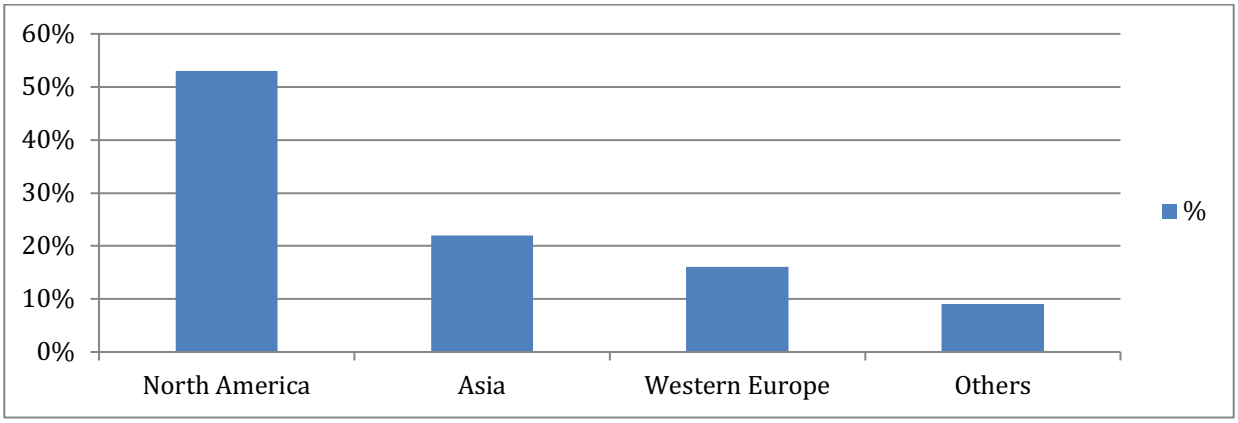
In particular, based on the content analysis, it was possible to characterize the main ways of implementing digitalization in the education system and describe the main tools used by teachers. Also, based on the cluster analysis, the main technologies and tools implemented in modern education were grouped. Factor analysis was used to characterize the main obstacles to the effective implementation of digitalization and to describe the main factors that affect the effectiveness of digital technologies. After that, the obtained data were compared with the results of modern scientific studies.

Results

Digital technologies are important components of the modern education system. Modern education is based on the use of various innovative technologies aimed at improving access to education and its quality in general. The international market of digital education platforms, unlike traditional education, which has a clear geographical link, has a number of advantages, including the ability to obtain knowledge regardless of location. Based on the countries in which revenue is generated from the implementation of digital education services (digital university), the structure of the global market by key geographic segments will have the following system, as shown in Figure 1.

Figure 1

Global structure of digital education services (by region)



Source: Sichkarenko (2018)

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Thus, digitalization is a current trend in the development of educational services in the world. When asked how often digital technologies are used in the educational process, the vast majority of respondents said that they encounter digital learning technologies every day (80 people answered). At the same time, 60 participants emphasized that they use innovations in their learning or teaching several times a week. Once a week, 30 respondents reported using technology (see Table 3 for details).

Table 3

Frequency of using digital technology

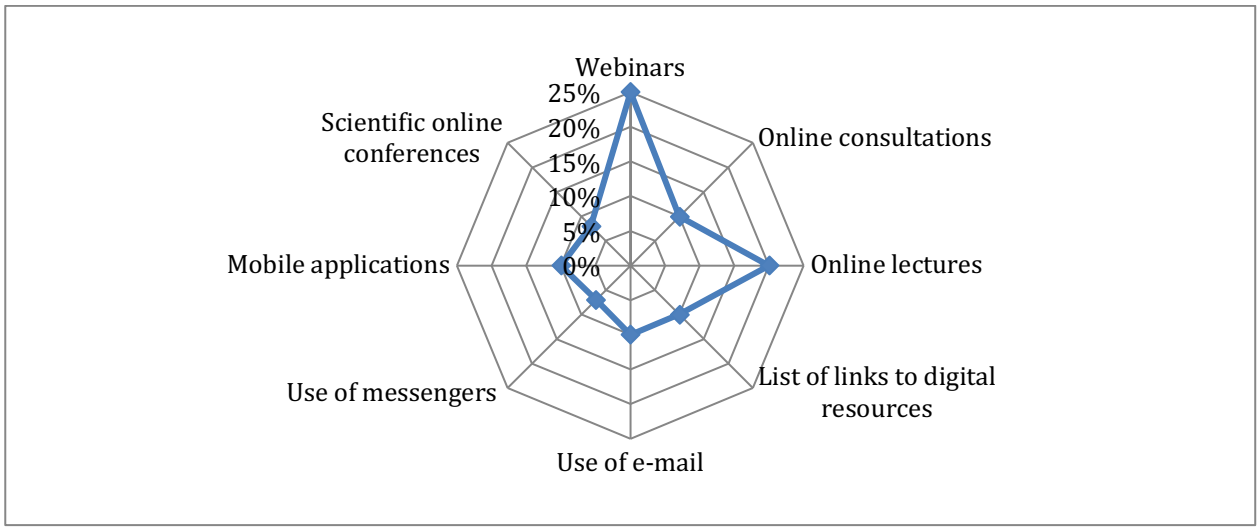
Frequency	N	%
Daily	80	37,91%
Several times a week	60	28,44%
Once a week	30	14,22%
Several times a month	25	11,85%

Source: Author's development

Specific digital tools that facilitate the organization of the learning space play an important role in the e-learning system. In particular, it has been determined that modern teachers often use webinars (online seminars) and remote lectures to organize digital learning spaces. Remote applications, online consultations, and remote conferences are also important tools. At the same time, the use of special communication resources, such as mail and messengers, is also important (See Figure 2).

Figure 2

Structure of the use of digital tools in digital education



Source: Author's development

Digital communications play an important role in the effective implementation of digital education. They contribute to the implementation of a person-centered approach and help improve the quality of educational services provided. The survey found that the most common communication channels for digital education are special communication messengers and applications (74 people indicated). Individual online platforms and email also play an important role (see Table 4).

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Table 4

Main communication channels in digital education

Digital tool	Number	%
Messengers	74	35,07%
Email	81	38,39%
Online platforms	54	25,59%
Other	2	0,95%

Source: Author's development

Thus, the most common communication tool in the digital learning system is e-mail. However, some messengers and online applications are also very popular, which demonstrates that teachers and students are aware of modern communication programs.

Based on the interviews conducted in the focus groups, it was determined that the use of digital technologies in the innovative learning space has a number of advantages. In particular, they contribute to accessibility. In particular, digital technologies make it possible to quickly disseminate educational information and organize learning from anywhere. At the same time, students also emphasized that it has become easier for them to study. With the help of digital technologies, all learning resources are available in one application and are easy to access. Thus, digital technologies contribute to the mobility of the learning system. Separately, the automation of education management systems and the use of intelligent systems contribute to the effective management of the learning space. Recent studies have also shown that artificial intelligence systems contribute to the effective assessment and control of the quality of knowledge (Spillere et al., 2018). A separate objective of this study was to determine the impact of digital technologies on the development of students' motivation to learn. This question concerned only teachers who, based on their observational teaching practice, should have noticed this aspect. Thus, the majority of teachers determined that digital technologies do indeed contribute to the greater interest of modern students (66 responses). At the same time, 7 people did not notice such an impact, and 14 people noted that these technologies have a negative impact on the development of motivation to learn (see Table 5).

Table 5

Does the use of technology affect the development of students' motivation to learn? (for teachers only)

Answer	Number	%
Yes, significantly improves motivation and engagement	66	75,86%
No impact is noticeable	7	8,05%
No, technology has a negative impact on motivation	14	16,09%

Source: Author's development

Thus, as Table 5 shows, most modern teachers believe that digital technologies significantly improve student engagement, but there are also those who have a negative attitude towards these technologies. As we found out, this is due to the difficulties that may arise on the way to using them. In particular, this may be due to the low level of digital literacy. Therefore, teachers with low digital competence may not be able to master all the features of these technologies and demonstrate them to students. In addition, cyber security is also an important challenge. In particular, digital learning platforms can be subject to digital attacks, which can negatively affect the organization of the learning space. Another difficulty is the underdevelopment of the material and technical base of the educational institution. If an educational institution has problems with its technical infrastructure, it affects the effectiveness of organizing a true digital university (Santoveña-Casal & Fernández Pérez, 2020;

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Veletsianos et al., 2021). The final question of the experiment concerned the general definition of the effectiveness of digital technologies (see Table 6).

Table 6

Final definition of the effectiveness of digital technologies

Answer	Number	%
Digital technologies are effective for organizing learning	177	83,88%
Digital technologies are not effective	13	6,16%
There is no noticeable impact	21	9,95%

Source: Author's development

Consequently, the final survey showed that most respondents consider digital technologies to be effective in organizing the learning environment. Thus, they improve the acquisition of knowledge, make it more accessible and contribute to the formation of an innovative learning space.

Discussion

The results demonstrated the effectiveness of digital technologies in the modern education system. In general, modern experts also emphasize the positive impact of the use of modern digital technologies in the system of training specialists of the future. In particular, according to Andersone (2020), innovation is an important component of modern curricula that should develop relevant skills for future professionals. Clennell, Peters and Sewart (2020) also proved that modern digital universities provide important services for students and contribute to the development of their digital skills. Important for comparison are the works that define students' attitudes towards the use of digital technologies. In particular, Baber (2020) characterized the peculiarities of students' perceptions of the introduction of online learning. Although in his study, the majority (50%) had no experience of using online resources and were not familiar with online education, the majority of respondents were positive about this form of knowledge acquisition. Also, Gökbulut (2020), who conducted a study among 27 students, described their opinions on the use of digital technologies in the distance education system. In general, the author also emphasized the effectiveness of this form of education. Rajab (2018) also compared the results of online learning of students based on the teaching of certain disciplines with the results of face-to-face learning. The author came to the conclusion that learning based on non-remote or blended learning is effective for providing educational services in war-affected areas. In addition, modern researchers argue that modern digital technologies should be used in traditional forms of face-to-face education; as they affect greater student engagement, make the learning process more innovative and more interesting for students (Hart-Davis, 2018; Bobro, 2024; Cavalcanti et al., 2021). Thus, modern works also emphasize the effectiveness of modern technologies in the educational process.

Some scholars emphasize the low efficiency of learning on e-learning platforms, as statistics show that the number of students who complete online courses ranges from 5 to 13% (Sichkarenko, 2018). As a rule, when a course has automated checking and control of work, more students complete the course than when the course uses superficial assessment (Rajab, et al., 2020). However, surveys conducted among students show that many of them use digital learning materials for self-study and are quite satisfied with the amount of information sent to them by their teachers. Moreover, many students combine the digital learning materials they receive with other sources of educational information on a particular topic. Thus, many participants in digital education implement independent learning, which is an important skill for the modern market.

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Moreover, the results showed that not all respondents were positive about the use of digital technologies in the educational process. This is due to the difficulties that may arise in their use. In particular, the results show that a low level of digital literacy can affect the effectiveness of digital technologies. Such opinions are also expressed by other scientists whose research has investigated the role of digital literacy (Almås, Bueie & Aagaard, 2021). Khan and Vuopala (2019) also noted that in the modern world, it is important for a teacher to master digital literacy. Therefore, skills in working with digital educational information, information resources, and applications are important for modern teachers (Gourlay, 2021; Lazinski et al., 2021; Rumble, 2019). According to Prullage (2019), the modern education system should be focused on a competence-based learning system, i.e., to train specialists who should have relevant skills that are in demand in the labor market. These opinions also correlate with this study. At the same time, modern scholars also emphasize the important opportunities of the digital education system, as it trains specialists who will have digital skills in the future, which will affect their potential in the labor market (Kubiv et al., 2020; SenthilVinayagam et al., 2020). Therefore, current research emphasizes the importance of digital technologies and identifies their potential for shaping the specialists of the future.

The novelty of this study is to assess the role of digital technologies in the digital education system based on a survey of students and teachers. At the same time, the main limitations of the study relate to the wide range of respondents, in particular, it is also important to approach this problem locally and determine the role of digital technologies in a particular educational institution. In addition, the data obtained were compared with the results presented exclusively in modern works (since 2018), so the contribution of previous studies was not taken into account. However, despite this, this work still contains significant novelty and emphasizes the importance of digitalization in the modern education system.

Conclusions and Implications

Thus, modern digital technologies are important components of the development of the modern education system. The study proved their value in the formation of future professionals with the skills of the 21st century.

The paper identifies that tool such as educational mobile applications, online platforms, learning resources, and communication messengers are important tools for implementing an effective digital education model. Respondents' answers show a positive impact of digitalization on learning, in particular, the majority of respondents identified the impact of digital technologies on increasing students' motivation and interest in learning.

At the same time, the study showed that there are several challenges to introducing digital technologies in education, including the importance of preparing teaching staff for widespread implementation of innovations, the availability of appropriate material and technical resources, and difficulties in organizing cyberspace. Despite these issues, digitalization continues to be a relevant trend, and these challenges open up new opportunities for improving the digital education system.

Suggestions for Future Research

This study has shown the effectiveness of the use of modern digital technologies in the system of digitalized education, however, and has opened up several important issues that require further detailed study. In particular, an important issue is to clarify the role of digital literacy courses for teachers in the system of implementing innovative educational tools. This will make it possible to determine their value and importance in modern education. This work should be based on assessments of teachers' attitudes toward digital literacy courses. Another important area, as demonstrated by this study, is to determine

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the role of cybersecurity in the system of organizing an effective digital learning space. Given the various information challenges, such a study would demonstrate the role of cybersecurity for modern learners. In addition, the next study should focus on the main difficulties of using digital technologies, in particular, it should emphasize the role of material and technical capabilities and how their improvement contributes to the development of educational services. A separate important problem that needs to be studied is the role of digital educational mass courses in the training of specialists. Based on the survey of students who have completed such courses, it would be worthwhile to evaluate the role of these digital resources.

At the same time, this study involved a wide range of respondents, and in order to confirm the results, it would also be worthwhile to conduct an experiment among teachers or students from the same region or educational institution. This would make it possible to compare the local data with a broader study. Thus, this work has opened up many new issues that require further detailed research by contemporary scholars.

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Conflict of Interest

None.

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