Research Article

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Impact of COVID-19 Pandemic on Academic Process in Higher Medical Institutions: Optimal Model of Organisation and Methodology of Teaching under Quarantine Conditions

Sharlovych Zoia[1*]

Aringazina Raisa[2]

Stepanova Halyna[3]

Kupriyanenko Angela[4]

Kravchenko Olena[5]

[1]International University of Applied Sciences in Lomza, Łomża, Poland
[2]Non-Commercial Joint-Stock Society, West Kazakhstan Marat Ospanov Medical University, General medicine, Aktobe, Kazakhstan
[3]Cherkasy Medical Academy, Cherkasy, Ukraine
[4]Municipal Higher Educational Institution, Zhytomyr Medical Institute, Zhytomyr Regional Council, Zhytomyr, Ukraine
[5]Cherkassy Medical Academy, Cherkasy, Ukraine
**Corresponding Author*

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Abstract

This research aims to establish the peculiarities of the COVID-19 pandemic's impact on the academic process in higher medical institutions and to develop an optimal model of organization and methodology of teaching under quarantine conditions for the students who studied in the speciality "Nursing". To achieve this objective, the comparison method was used, which enabled us to develop teaching principles for medical students under distance learning conditions. The model of teaching was based on diagnosing students' psychological state (fears, burnout, lack of motivation), mastering a system of theoretical medical knowledge (learning human morphology and anatomy, human diseases, human disease prevention, specificity of pharmaceuticals), ensuring practical sessions (practical diagnosis of anatomy, virtual human technology-assisted training), applying project technology (development of creative skills). The results of a sociological survey showed that the majority of students confirm the effectiveness of the system of teaching theoretical medical knowledge based on the use of the Skyscape application. The assessment of the effectiveness of medical students' education showed that 57.0% of students with an average score of 0.91 and 53.0% of students with an average score of 0.93 received high practical and theoretical knowledge, respectively.

Keywords: *Distance learning, Skyscape application, Methods of teaching, Practical diagnosing, Psychological state*

1. Introduction

Socioeconomic changes have predetermined transformations in the education system, seeking refined approaches to learning. The COVID-19 pandemic has led to the reorientation of the education system towards using online technologies (Kranjcevic et al., 2020). Despite Isaac Pitman's first steps towards distance learning in 1840, the changes in the education system caused various challenges that both instructors and students faced (Olson, 2022). This refers to the fact that students had to be self-disciplined, while instructors had to develop an academic curriculum for its implementation in distance learning, and resources must be available (technologies, materials, etc.) The positive aspects of distance learning imply flexible learning schedules, access to information technologies, and the absence of pressure made by other students (Reguera & Lopez, 2021; Aaraj et al., 2021). The COVID-19 pandemic outbreak resulted in all educational institutions making a shift to a distance learning format, and medical education institutions are no exception. In Ukraine, the distance learning format has become widely spread since March 2019 (Downer et al., 2018; Martín et al., 2021).

The development of new learning mechanisms fosters an increasing amount of self-study activities for medical students and academic disciplines, which have an impact not only on students' vocational literacy but also extend their digital ("IT and e-health", "Innovative approaches in Medicine", etc.) (Cavalieri, 2021). The organisation of the distant mode for clinical academic courses, oriented towards diagnosing human diseases (cardiology, pulmonology, gastroenterology, etc.) and dependent on direct instructor-student interactions, evokes special concern (Alsaywid et al., 2021). To solve this problem, instructors make use of foreign lectures, video recordings, and materials (clinical management of severe acute respiratory infection, emerging respiratory viruses, including COVID-19: methods for detection, prevention, response, and control) as global best practices (Vaskivska et al., 2021). Online education shall be based on active instructor-student interaction, correct visualisation of learning content, and the possibility to apply the theoretical knowledge students gain during practical sessions (Sannathimmappa et al., 2022).

In the framework of planning an online learning system, it is necessary to consider students' various thinking processes and the pace of their learning, which requires additional efforts from instructors to be made (Ahmadipour, 2022). Firstly, it is necessary to ensure that students master theoretical content within their learning capacity (Stylianidou & Mavrou, 2021). Platforms such as Zoom, Google Meet, and various messaging apps (e.g., Facebook, Telegram) are used to deliver theoretical content (Nathaniel et al., 2021). During practical sessions held in the distance format for teaching medical students, challenges arise due to the lack of interactions with patients and instructors, as well as the absence of explanations, mock-ups, and laboratories (Fuhrmann et al., 2021).

The effectiveness of online learning, which implies students' independence, depends on the mechanisms of learning material presentation and the degree of student-instructor communication (Mirsepassi et al., 2022). Instructors' professionalism ensures students' training in non-standard learning processes and accessibility to learning materials. Such a format of teaching contributes to the development of students' creative and critical thinking, independence, and self-discipline (Moschovis et al., 2022). The automated learning system allows students to share experiences, track their performance, and ensure ongoing access to learning materials (Toader et al., 2021).

The objective of this paper is to reveal the peculiar features of the impact of the COVID-19 pandemic on the academic process in higher medical institutions, specifically focusing on the formation of an optimal model for the organisation and methodology of teaching "nursing students under quarantine conditions.

The hypothesis of this paper proposes the development of new approaches to distance learning that have not been previously suggested, with their effectiveness substantiated.

The research tasks are as follows:

- To develop the principles of the model of teaching medical students under quarantine

conditions;

- To reveal the significance of the principles of distance learning for students and to compare the obtained data by applying Cohen's coefficient;
- To establish the effectiveness of teaching medical students in terms of theoretical and practical skills, and to assess the skills the students gained during distance learning.

2. Literature Review

The approaches to distance learning for medical students were defined based on the analysis of literature data. The transition from traditional to distance learning was caused by the COVID-19 pandemic. To ensure online education for Indian medical students, the focus was on exploring the literature used in the academic curriculum in the Western region of Europe, as well as utilising video lecturing and monthly student assessments. The results showed that students were interested in this learning format, however, the effectiveness, in terms of academic and clinical performance, was not clearly revealed (Ciano et al., 2022). To ensure the distance learning format, the majority of educational institutions used distributed learning materials and virtual discussions, which encouraged student-instructor communication. The use of Internet platforms has influenced the remodulation of the education system and the distribution of learning time (Giordano et al., 2021). In the context of radiation oncology, distance learning incorporated virtual learning platforms where students could discuss specific clinical cases. The lessons were conducted by radiologists and higher education institution instructors, enabling the majority of medical students to achieve a high level of knowledge (Kahn et al., 2021). For teaching medical students across specialties, a quantitative analysis of literature data and the assessment of podcasts and videos was conducted. The focus on learning theoretical content contributes to enhancing memory ability and memorising larger amounts of learning material. The most effective platforms for learning podcasts are Spotify, Apple Podcasts, Google Podcasts, Stitcher, and TuneIn. To ensure effective teaching, it is necessary to categorise podcasts, which contributes to extending the general knowledge framework (Malka et al., 2021). The distance learning process, provoked by the COVID-19 pandemic, necessitated an increased number of clinical tutors to assess students' progress resulting from their virtual technology-assisted learning. Control and assessment of students' knowledge are important elements of distance learning. The use of the Ecological Momentary Assessment (EMA) application helped to establish students' level of professionalism. The control of knowledge was based on achievements and reflexive grades (Lazzari et al., 2021). Managing practical classes during distance learning in the framework of the academic subject "Medical Chemistry" is an intricate problem, as teaching principles must be based on presenting 2-D and 3-D molecular architectures to facilitate the visualisation of chemical compounds and chemical interactions. For conducting practical sessions on Medical Chemistry, it was decided to apply a VR simulation based on restricted interactivity, which facilitated increased student engagement in a gaming format (Falah et al., 2021). Online education is possible to implement with the help of YouTube, as the platform features videos demonstrating the techniques of treatment and various surgical procedures. The videos grouped by topics such as "access to the femoral artery" and "access to angiography" help students to understand the basic information. However, deeper expertise necessitates direct contact with vascular experts and vascular surgeons with patients (Pitcher et al., 2017).

The review of the literature data revealed that the main focus is on the use of video lectures, while the question of developing refined academic curricula needs more elaboration. The relevance of this paper lies in developing new approaches for online teaching of medical students because the majority of the studies feature common mechanisms of academic process organisation and lack sufficient evidence of their effectiveness.

3. Methodology

The first stage of the research was focused on developing teaching principles that would enable the construction of an optimal model for organising the learning process under quarantine conditions. The principles of teaching were as follows:

- Diagnosing students' psychological state;
- Mastering the system of theoretical medical knowledge;
- Ensuring practical sessions;
- Project technology (development of creative skills).

The comparison method was used to develop the teaching principles, enabling the identification of the most significant learning parameters through the comparison of interrelated indicators (Turana et al., 2022). In the curriculum development process, the focus was placed on the cognitive component. For the experimental group, detailed practical sessions were planned following a thorough consideration of the theoretical framework. To implement the curriculum, access to a laptop/tablet PC, Internet connectivity, and the Skyscape and Virtual Practice for Doctors applications were necessary.

The second stage of the research was focused on establishing the significance of the principles used in the model of teaching medical students under quarantine conditions. This stage was implemented after 4 months of teaching. Ninety Ukrainian students who specialized in Nursing were selected to participate in the experimental academic curriculum. To select the participants for the experiment, it was decided that they must be second-year students aged 18-20, who were undertaking the "Nursing" specialty, as these students had already developed their vision of the theoretical learning program. Ethnic and gender parameters were considered irrelevant, as they were not expected to influence the final results of the research. Initially, 110 students were planned to be engaged, but 20 students had a different specialty, causing divergences in the academic curriculum. All the participants of the research volunteered to participate and signed written consent forms.

The significance of teaching principles was established with the help of a sociological survey, which is the most widespread method for collecting the necessary data among a large number of respondents (Turana et al., 2022). The sociological survey was conducted online, in which students were asked to send their responses regarding their preferences about the teaching principles to instructors' emails within 24 hours. To compare the significance of teaching principles between students, Cohen's coefficient was calculated using formula 1 (Nugroho et al., 2021):

$$d = \frac{(M_1 - M_2)}{\sqrt{\frac{S_1^2 + S_2^2}{2}}}, \quad (1)$$

where,

M_1, M_2 – average value of the first and second indicators;

S_1, S_2 – standard deviation of the first and second indicators, respectively;

When interpreting Cohen's coefficient, it is necessary to compare the obtained value with 0, which confirms a strong interrelation between the principles of teaching, or with 1, which confirms the absence of such interrelation.

The third stage of the research included establishing the effectiveness of medical students through the grading of their practical and theoretical knowledge. The authors determined the effectiveness of knowledge based on the formula 2:

$$k_{ef} = \frac{(E_p + O_e + D) \times k_l}{t}, \quad (2)$$

where,

E_p – grades gained for the period of studying;

O_e – respondents' evaluation of the academic process organisation;

D – expected assessment of the learning process results made by an instructor;

k_l – Net Promoter Score (1/2 – neutral, 1 – low, 3 – high)

t – time spent learning.

A high level of knowledge was assigned to a student if they had a good command of theoretical and practical information, with a score ranging from 0.9 to 1.0.

A sufficient level of knowledge was assigned to a student if they had general theoretical knowledge and could apply it practically but made up to three mistakes, with a score ranging from 0.74 to 0.89.

A low level of knowledge was assigned to a student if they did not have a good command of theoretical and practical knowledge, with a score ranging from 0.6 to 0.73.

For comparing the interrelation between levels of theoretical and practical knowledge, Cohen's coefficient was calculated based on the analogy with formula 1, as shown in the second stage of the study.

The third stage of the study included establishing the skills that students developed upon completion of their distance learning. The authors of the paper made a percentage distribution of the responses based on the observation and comparison of the skills before the study had been initiated.

The processing of the numeric results was done using Microsoft Excel software, which enabled the calculation of the required indicators and ensured the accuracy of the provided data. The authors affirm that ethical issues were strictly followed in the paper in accordance with the guidelines of the World Medical Association (2022). In compliance with ethical provisions, the rights and obligations of the participants of the experiment were observed in this study.

This paper has limitations in measuring the effectiveness of nursing students. However, the authors suggested the principles of teaching for the specialty in a distance format, their significance for students was revealed, as well as the results of their effectiveness in terms of theoretical and practical knowledge were highlighted.

4. Results

The academic process in medical institutions changed because of the COVID-19 pandemic, which caused a range of concerns and called for amending the education approaches. The authors of the paper developed the model for the system of teaching nursing students under quarantine conditions, which embraced the provisions as shown in Figure 1.

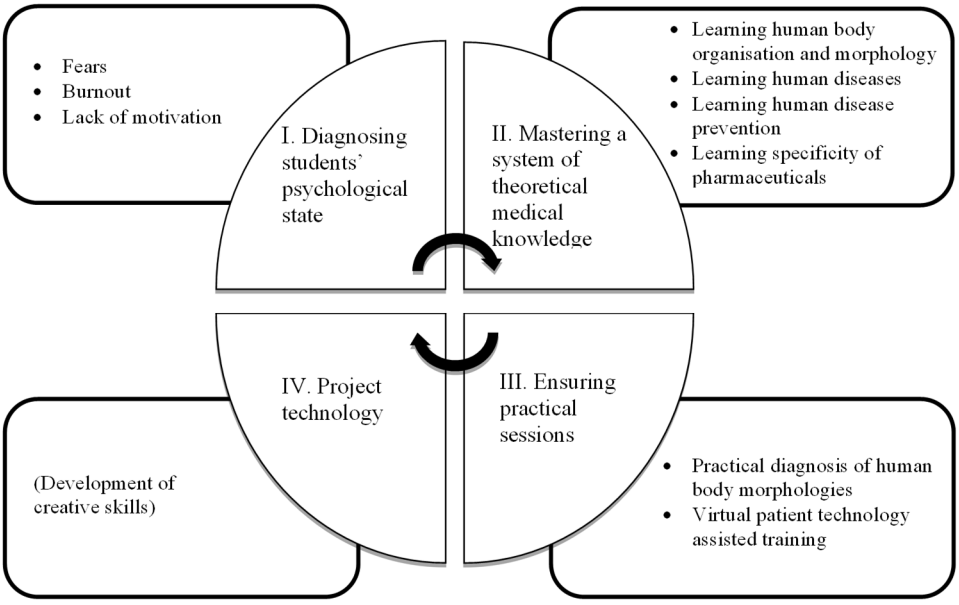

Figure 1: The academic curriculum model for teaching medical students under quarantine.

I. Diagnosing students' psychological state during distance learning. This parameter is significant for teaching medical students under quarantine conditions as it involves identifying fears and complex aspects that need to be addressed for an effective teaching process. Students' fears were found to be related to the lack of communication, direct contact with an instructor, and self-organising their learning process. To address these concerns, students underwent psychological training once a week to reveal aspects requiring a solution, which directly influenced their engagement in the learning process.

II. Concerning the curriculum model for teaching students, the second principle was based on mastering a system of theoretical medical knowledge, which is fundamental for future medical specialists' qualifications. To help students master theoretical information, the Skyscape application was implemented into the education system. This application served as a universal source of medical information, providing details on human anatomy and practical recommendations for managing patients. Special attention was given to learning anatomy and morphology, human diseases, human disease prevention, and the specificity of pharmaceuticals in the systems of theoretical medical knowledge. These categories were distinguished because students should primarily master human morphology and anatomy, enabling them to focus on learning the organisation of the human body, both externally and internally, as well as studying individual peculiarities of body changes under the influence of external factors (meteosensitivity, accidents, stressful situations, etc.). The acquisition of theoretical knowledge was organised as teamwork, which involved dividing students into subgroups of 5 people. This teamwork approach facilitated knowledge exchange and supported communication under the conditions of distance learning.

III. The third principle was based on ensuring practical sessions, which hold special importance for nursing students, requiring proper attention. To implement practical sessions under remote conditions, students were offered video lectures featuring all the details of human anatomy replaced with mock-ups, typically shown during offline classroom activities. Additionally, virtual learning of the human body was facilitated with the Virtual Practice for Doctors, allowing for communication during virtual practical sessions. The practical diagnosis of human body morphologies, assisted by a virtual human, played a crucial role in acquiring practical skills under remote conditions, significantly influencing the professional skills development of future medical workers. At this stage, anatomy was studied using the 3D format, which enhanced the visualisation of human anatomy.

IV. The project technology for creative skills development is the final principle of distance teaching for students, as it is designed to foster their creative thinking, which is essential in approaching non-standard clinical cases. During this stage, students were encouraged to suggest non-standard ways of treatment for specific clinical cases, thereby activating their brain activity and enhancing their learning motivation. Moreover, students were divided into groups at this stage, allowing for the demonstration of various mechanisms for resolving a certain clinical case.

Based on the suggested model of teaching, the sociological survey was conducted among students to identify the principle that was the most important for the acquisition of required knowledge for nursing students. To verify the correlation of statistical data between each other, Cohen's coefficient was calculated.

Table 1: Significance of the principles of the model of teaching nursing students under quarantine conditions

Calculation of Cohen's coefficient					
Teaching model principle	Distribution of respondents' answers	Diagnosing students' psychological state	Mastering a system of theoretical medical knowledge	Ensuring practical sessions	Project technology (development of creative skills)
Diagnosing students' psychological state	27.0%	-	0.019	0.012	0.092
Mastering the system of theoretical medical knowledge	29.0%	0.019	-	0.023	0.097
Ensuring practical sessions	26.0%	0.012	0.023	-	0.083
Project technology (development of creative skills)	18.0%	0.092	0.097	0.083	-

The results of the sociological survey showed that the majority of students consider mastering a system of theoretical medical knowledge as the most elaborate principle of the teaching model. These conclusions are based on the fact that the learning of theoretical materials was presented in a detailed manner, providing students with access to all the lectures through the Skyscape application, as well as enabling them to discuss and communicate with an instructor directly during sessions.

The further stage of the research was focused on measuring the effectiveness of the knowledge gained after 4 months of distance learning format. The comparison of teaching effectiveness was conducted in terms of theoretical and practical knowledge after 4 months of teaching.

Table 2: Comparison of the effectiveness of teaching medical students

The teaching effectiveness degree	Practical knowledge (% students/average grade)	Theoretical knowledge (% students/average grade)	Comparison of indicators with the help of Cohen's coefficient
High	57.0% / 0.91	63.0% / 0.93	0.091
Sufficient	39.0% / 0.83	35.0% / 0.80	0.084
Low	4.0% / 0.52	2.0% / 0.57	0.037

Despite the lack of direct interaction with mock-ups and people, students managed to attain high and sufficient levels of practical knowledge. The utilisation of the Virtual Practice for Doctors application and the 3D format of learning facilitated the acquisition of human anatomy knowledge. This was possible because students were divided into subgroups for learning theoretical knowledge, which included studying human anatomy and morphology, human diseases, human disease prevention, and the specificity of pharmaceuticals. This approach allowed for organising detailed academic processes and maintaining communication via the Skyscape application. The comparison of indicators with the help of Cohen's coefficient, in the context of practical and theoretical knowledge, enabled us to reveal the interrelation between the effectiveness of the gained grades.

For establishing the impact of COVID-19 on the academic process in medical education institutions, we not only assessed the effectiveness of teaching principles but also examined the skills students acquired during their learning. The results showed that 30.0% of students developed their skills independently by searching for and learning additional medical materials. The development of self-study skills is linked to self-discipline and personal engagement in acquiring a high level of medical knowledge. Additionally, students' cognitive abilities (25.0%) and communicative

competencies (25.0%) were found to have been equally developed. The cognitive abilities are connected with the activation of brain functions, development of thinking, understanding, and logical interrelations. Students' communicative competence was also developed, despite the distance format of learning. The development of communicative skills was achieved during practical sessions through virtual communication with a patient, as well as through interactions with instructors during these sessions. However, creative thinking was developed to a lesser degree (20.0%) because it required having a high level of basic knowledge, which demanded additional training efforts from the respondents.

5. Discussion

The study of the approaches to the organisation of distance learning was made based on literature data analysis. For teaching junior surgeons during the COVID-19 pandemic, the platforms like Zoom or Google Classroom, along with YouTube recordings, were utilised. Google Forms were used for feedback, and YouTube Studio allowed for watching videos about procedures and surgeries. The comparison between online and offline learning modes showed the advantages of online learning, enabling live interactive interactions between students, instructors, and patients (Laloo et al., 2020). The detailed study of the curriculum for distance teaching of future doctors at Queen Mary University of London showed its increasing popularity among students, however, the low-performance indicators cast doubt on its effectiveness. To confirm or refute these conclusions, in this paper, we analysed the practical activity of students from 2013 to 2016. The results showed that the highest indicators are observed among students from Australia and New Zealand, Asia and Europe, and that all the sociological survey participants conducted clinical treatment of patients. The results show that this curriculum of distance learning has advantages as compared to other courses and helps to train traumatologists at a high level. For learning the materials in terms of distance learning, QMUL Trauma Sciences MSc is used (Schyma et al., 2019). Within this research, the comparison between online and offline learning was not conducted, as it was done in the works mentioned above. Nevertheless, the paper suggests a comparative analysis of the effectiveness of teaching students in terms of the distribution of theoretical and practical knowledge in the framework of the distance learning process. The control of knowledge is shown in Table 2, where the levels of effectiveness are divided into high, sufficient, and low.

Online learning has the same effectiveness as offline one as a result of the creation of suitable conditions and provision of the necessary materials. During distance learning, students should maintain their self-control and self-discipline. The comparison of traditional offline learning of SMS training, e-learning, and the blended approach showed that blended learning was the most effective form of teaching medical students, considering the best results in patient care, engagement in the learning process, and assessment of competence. The Flinders Program software is of great importance for learning information: Problem and Goals, as it provides access to theoretical materials (Munro et al., 2018). The comparison of traditional and distance learning was conducted based on students' performance and satisfaction. The curriculum of King's College London was divided into 10 topics for teaching, using both traditional lectures and e-learning. The results indicated that the average grade of testing during distance learning was 58.0%, compared to 55.0% for traditional learning. Moreover, 87.0% of students preferred the distance learning process, which positively impacted students' motivation and resulted in higher grades (Petrarca et al., 2018). In the framework of the suggested study, the model of teaching was developed directly by the authors and was not based on existing teaching methods. The focus of the teaching model included diagnosing students' psychological state, mastering the system of theoretical medical knowledge, ensuring practical sessions, and incorporating project technology.

The academic process modifications in Ukrainian medical institutions were prompted by the COVID-19 pandemic, necessitating the reorganisation of the academic process and the development of technical means (computers, continuous Internet, etc.). For practical sessions on pediatric

dentistry, the Microsoft Teams software was utilised, facilitating file exchange and chat discussions. The built-in calendar provided information on control assessments to students. Instead of working with real patients, case problems and algorithms for practical skills experience were used during learning (Lisetska, 2020). The advancement of the latest technologies has greatly facilitated the remote teaching process, and medical education institutions are also benefiting from these advancements. The use of Blackboard Learn software has highlighted the advantages of distance learning, including effective tools for knowledge assessment, a robust security system, and data confidentiality (Wu & Plakhtii, 2021). While this paper also established the effectiveness of the developed teaching model, the focus was not on the effectiveness of control assessments, but rather on the results of assessing students' level of knowledge.

The literature data analysis suggested in the "Discussion" section showed the majority of existing works focused on the comparative analysis of online and offline learning modes, exploring their advantages and disadvantages. The novelty of this study lies in the development of a new model of teaching principles for distance teaching nursing students. By implementing this model, the study established the effectiveness of teaching among students and revealed their acquired skills, which were further improved through the teaching process.

6. Conclusions

For investigating the impact of COVID-19 on the academic process in medical education institutions, we suggested a model of teaching for distance learning, which involved the following elements:

- Diagnosing students' psychological state;
- Mastering the system of theoretical medical knowledge;
- Ensuring practical sessions;
- Project technology for developing creative skills.

Diagnosing students' psychological state in the framework of teaching enables us to identify the challenges arising from distance learning and their impact on students' motivation.

Mastering a system of theoretical medical knowledge became possible due to the utilisation of the Skyscape online application, which contains a comprehensive repository of informational materials on human anatomy, possible diseases, pharmaceuticals, and more. To foster communication and knowledge exchange among students, they were grouped into subgroups.

Ensuring practical sessions became possible through the use of video lectures, SD mock-ups, and Virtual Practice for Doctors software.

Project technology for developing creative skills involved fostering creative thinking and the ability to apply non-standard mechanisms in solving clinical cases.

The prospective studies may refer to the comparison of theoretical and practical skills gained as a result of teaching nursing students in a distance learning mode.

The academic curriculum model developed in this study could serve as a guideline for designing curricula for students pursuing related specialties and postgraduate education.

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