GEORGIAN MEDICAL NEWS

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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned
Requirements are not Assigned to be Reviewed.**

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**,ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შედგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმების (ინგლისურ,რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენ-ტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ,რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი,მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემა-ჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები,ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტო-სურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი,ანათლების შედგბის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სუ-რათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხო-ური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიდრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამული, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი,წელი,ჟურნალის №,პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიდრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანე-ლის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა,მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა,რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შე-ჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

Содержание:

VIRTUAL ENVIRONMENTS AND HUMAN ANATOMY LEARNING ACHIEVEMENTS IN UNIVERSITY STUDENTS

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Abstract.

Introduction: Virtual learning is characterized by the fact that the sender and the receiver are not present in the development of the learning sessions or in the same physical space; it can be synchronous or asynchronous. In certain subjects such as Human Anatomy, the teaching was face-to-face, which is why the question arose whether the virtual teaching of human anatomy was effective or ineffective.

Objective: To determine the relationship between virtual environments and learning achievements in the subject of human anatomy in students of a Peruvian university during the COVID-19 pandemic.

Methods: Quantitative, descriptive correlational study, 187 undergraduate students participated in the Human Anatomy subject of the Faculty of Human Medicine of the Universidad Nacional Mayor de San Marcos. The virtual survey was used as a technique and a Likert-type scale as an instrument, whose content validity coefficient was 0.9062 and reliability, applying Cronbach's Alpha, was 0.956.

Results: Of 100% (187), 82.9% (155) of the respondents considered the virtual environment favorable and 17.1% (32) considered it unfavorable. Of those who responded favorably, the learning achievement was considered: Good 53.5% (100); regular 21.4% (40); greater 6.4% (12) and minimum 1.6% (3). The virtual environment and learning achievements are related according to Pearson = 7.785, p value= 0.051 less than $\alpha = 0.10$ and there is a moderate association with Cramer's V = 0.204.

Conclusions: There is a moderate association between the virtual environment and the learning achievement of the subject of human anatomy.

Key words. Learning, anatomy, students.

Introduction.

Virtual environments refer to spaces designed to achieve specific learning objectives in the current educational context, virtual environments have become central tools for teaching and learning [1,2]. These digital spaces are designed to facilitate the learning process by integrating two fundamental components: the pedagogical function, which refers to the educational methodology employed, and the technological infrastructure, which includes both the software and the organization of the virtual space, such as virtual classrooms, schedules, and interaction systems. In such environments, teachers and students do not share a physical space, presenting challenges and opportunities for pedagogy [3].

The Ministry of Education of Peru identifies three essential pillars of virtual learning: interaction, collaboration, and production. Interaction involves a simultaneous or deferred learning process between teachers and students, as well as among the students themselves [4]. Collaboration refers to joint activities facilitated by technological means, promoting skills such as teamwork. Finally, production focuses on experiences designed by both teachers and students using the tools available on virtual platforms, resulting in tangible evidence of learning [5].

There are two main modalities of virtual teaching: synchronous and asynchronous. In synchronous teaching, teachers and students interact in real time, allowing immediate resolution of questions during the class. Conversely, asynchronous teaching enables students to work at their own pace using pre-recorded or pre-provided materials, encouraging self-management in learning [5].

The COVID-19 pandemic forced educational systems worldwide to abruptly transition to virtual environments due to social isolation and distancing measures implemented to control the spread of the virus. This transition particularly impacted subjects traditionally taught in person, such as human anatomy, a key discipline in the training of health professionals, which has historically relied on the direct observation and physical manipulation of anatomical models and cadavers [6].

The challenge posed by the pandemic sparked a debate on the feasibility of teaching subjects like anatomy through virtual platforms, considering that such courses require a high degree of interactivity, three-dimensional visualization, and spatial understanding. Therefore, the primary objective of this study is to evaluate to what extent the implementation of a virtual environment can replace, complement, or enhance the learning experience of a highly visual and practical subject like human anatomy, providing evidence on the effectiveness of digital teaching in fields traditionally dependent on in-person instruction.

Methods.

This quantitative study employed a non-experimental, descriptive-correlational design with the objective of analyzing the relationship between virtual environments and learning outcomes in the Human Anatomy course for undergraduate students. The research was conducted at the Faculty of Human Medicine of the National University of San Marcos, Lima, Peru, during 2021. The sample consisted of 187 students enrolled in the course during the academic years 2020 and 2021.

The virtual classroom setting in this study offered a combination of synchronous and asynchronous activities. Participants engaged in real-time instruction during scheduled sessions and complemented their learning through self-directed study. Teachers assigned homework that students submitted via

the educational management system, facilitating continuous engagement and feedback.

The data collection technique used was a survey, employing a Likert-scale-based questionnaire designed to evaluate various dimensions of the virtual environment and its impact on learning. The instrument included 39 items distributed across dimensions such as the depth of subject content, interactivity, the relationship between the virtual classroom and in-person teaching, scalability and standardization, materials and content, the impact of images, accessibility, and usability. Each item was measured using a three-point Likert scale with the following frequency categories: Never (0 points), indicating that the evaluated aspect was not present or experienced in the virtual learning environment; Sometimes (1 point), reflecting occasional or intermittent presence of the evaluated aspect; and Always (2 points), representing consistent or continuous presence of the evaluated aspect. These categories allowed for a quantitative assessment of each dimension's presence in the teaching-learning process and facilitated classification into overall favorable and unfavorable perceptions based on average scores.

The analysis of responses focused on two global categories: favorable and unfavorable. This classification allowed for an evaluation of student perceptions regarding each of the mentioned dimensions and facilitated statistical analysis to verify the existence of a significant relationship between virtual environments and learning outcomes.

Regarding the validity of the instrument, the content validity coefficient (CVC) was employed for each item, achieving high validity by summing the obtained values and dividing them by the total number of questions. Additionally, a pilot test was conducted with 19 students, and the Cronbach's Alpha coefficient was used to measure internal reliability, yielding satisfactory results that validated the instrument's consistency.

For data processing, SPSS software version 25 was used, along with Microsoft Excel to support descriptive analysis. Measures of central tendency and standard deviation were calculated to evaluate the distribution of responses. To test the hypotheses, Pearson's chi-square test was employed with a 5% level of significance.

Results.

According to the data obtained (Table 1), 61.5% of the students reported a "Good" learning achievement, while 9.1% reached a "Superior" level. The virtual environments were considered favorable by 82.9% of the students, and 66.8% perceived a good depth in the topics addressed in the course. In addition, the majority found the social interaction (67.4%) and virtuality (85.6%) favorable.

Bivariate analysis (Table 2) showed a significant association between virtual environments and learning achievement (p=0.050), as well as between social interaction and learning achievement (p=0.005). In both cases, students who perceived these aspects as favorable tended to achieve better results. However, other dimensions such as virtuality (p=0.395), scalability (p=0.215), and materials and content (p=0.133) did not present significant associations with learning achievement.

Table 1. Frequencies of virtual environments and their dimensions about the human anatomy course in nursing students (n=187).

	Frequency	Percentage (%)
Learning achievements		
Minimal	6	3.2
Regular	49	26.2
Good	115	61.5
Superior	17	9.1
Virtual environments		
Favorable	155	82.9
Unfavorable	32	17.1
Level of subject depth		
Favorable	125	66.8
Unfavorable	62	33.2
Social interaction		
Favorable	126	67.4
Unfavorable	61	32.6
Virtuality		
Favorable	160	85.6
Unfavorable	27	14.4
Scalability and standardization		
Favorable	172	91.9
Unfavorable	15	8.1
Materials and content		
Favorable	163	87.2
Unfavorable	24	12.8
Image impact		
Favorable	169	90.4
Unfavorable	18	9.6
Accessibility and usability		
Favorable	164	87.7
Unfavorable	23	12.3

Discussion.

The findings of this study are consistent with previous research highlighting the positive role of virtual environments in education. For example, Ponce [7] argues that academic training in virtual environments is adequate, as students develop skills to search, verify, and generate knowledge. This autonomous learning process aligns with our research results, which indicate that virtual environments enhance both the acquisition of knowledge and students' ability to integrate it effectively [8].

Regarding the depth of content in virtual environments, our results align with those of Lara et al. [9], who concluded that these platforms foster a greater volume of information and better knowledge retention. The ability of students to access a wide variety of resources and delve into the material without the limitations of traditional classrooms may explain the positive impact observed on learning [10].

Similarly, interactivity within virtual environments was a critical factor in the teaching process. Padilla et al. [11] found that interactivity in these environments enhances personal and interpersonal competencies, fostering more dynamic and collaborative learning. Our study observed a similar trend, where interaction between students and teachers, mediated by virtual tools, strengthened the development of critical and communication skills essential for professional training [12].

Table 2. Bivariate analysis between learning achievements and virtual environments and their dimensions (n=187).

Learning achievements									
	Minimum	%	Regular	%	Good	%	Superior	%	p-value*
Virtual environments									0.050
Favorable	3	1.9	40	25.8	100	64.5	12	7.7	
Unfavorable	3	9.4	9	28.1	15	46.9	5	15.6	
Level of subject depth									0.090
Favorable	2	1.6	31	24.8	83	66.4	9	7.2	
Unfavorable	4	6.5	18	29.0	32	51.6	8	12.9	
Social interaction									0.005
Favorable	1	0.8	28	22.2	87	69.0	10	7.9	
Unfavorable	5	8.2	21	34.4	28	45.9	7	11.5	
Virtuality									0.395
Favorable	4	2.5	41	25.6	101	63.1	14	8.8	
Unfavorable	2	7.4	8	29.6	14	51.9	3	11.1	
Scalability and standardization									0.215
Favorable	5	2.9	46	26.7	108	62.8	13	7.6	
Unfavorable	1	6.7	3	20.0	7	46.7	4	26.7	
Materials and content									0.133
Favorable	5	3.1	45	27.6	101	62.0	12	7.4	
Unfavorable	1	4.2	4	16.7	14	58.3	5	20.8	
Image impact									0.317
Favorable	5	3.0	42	24.9	108	63.9	14	8.3	
Unfavorable	1	5.6	7	38.9	7	38.9	3	16.7	
Accessibility and usability									0.846
Favorable	5	3.0	43	26.2	100	61.0	16	9.8	
Unfavorable	1	4.3	6	26.1	15	65.2	1	4.3	

* Chi-square

The relationship between virtual classrooms and learning also showed positive results, indicating that incorporating information and communication technologies into e-learning motivates students. Our research suggests that virtual classrooms provide an environment that fosters active participation. This is partly due to the flexibility and accessibility these environments offer, which increases engagement from both students and teachers [13].

Another relevant aspect was the scalability and standardization of virtual environments. Using platforms such as Wix to develop digital portfolios for courses like anatomy promoted more enduring learning [14-16]. In our research, this standardized approach not only facilitated the management of large numbers of students but also maintained the quality of the teaching process, suggesting that virtual environments can expand without compromising educational quality.

Materials and content in virtual environments were also positively evaluated. The use of digital tools such as WhatsApp, Zoom, Google Meet, and Classroom not only facilitates access to information but also promotes autonomy and self-management in learning [5,6,13]. Our research found that these platforms improve the availability of educational content, which is crucial for ensuring continuous and accessible learning.

The impact of images in virtual environments was identified as a key resource in the teaching process. Digital images enable a better understanding of concepts by clearly and accurately reflecting reality [17,18]. This finding aligns with our results, where the use of images on virtual platforms not only complemented theoretical content but also facilitated students' internalization of concepts.

Finally, the accessibility and usability of virtual environments were other relevant aspects identified in our research. Platforms like Moodle and Canva were perceived by students as highly accessible and easy to use. This aspect is crucial, especially in contexts where connectivity may be limited, as it ensures students can access educational resources without significant technological barriers [19].

One of the main limitations of this study is its cross-sectional design, which prevents establishing causal relationships between the use of virtual environments and the observed learning outcomes. Additionally, the data is based on students' perceptions, which may introduce subjective biases in the responses. The sample was also limited to a single educational institution, potentially restricting the generalizability of the findings to other populations or educational contexts. Lastly, variability in students' access to technology and the quality of connectivity may have influenced the learning experience, which was not controlled in this study. A key limitation of this study is the exclusive focus on nursing students, which may not fully capture the challenges faced by students in other health-related disciplines, such as medical students, who require technical dissection skills that are more challenging to develop in a virtual environment. Future studies should consider including diverse student populations to explore discipline-specific needs and outcomes in virtual learning settings.

Future research should continue to explore the use of virtual environments, considering different methodologies and populations, to further understand their impact and effectiveness in higher education. As technology evolves, it is essential for educational institutions to adapt their teaching strategies to include digital tools that enrich the learning experience, promoting more inclusive and accessible education.

Conclusion.

The results of this study demonstrate that virtual learning environments effectively promote academic achievement in nursing students taking the human anatomy course. The analyzed dimensions, such as interactivity, scalability, and the impact of materials, significantly contribute to the learning process, facilitating the acquisition of knowledge and the development of key competencies. These conclusions align with previous research emphasizing the importance of quality and accessibility in virtual environments to optimize learning in contemporary educational contexts.

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