

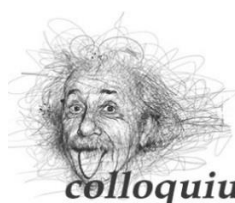
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<https://doi.org/10.5281/zenodo.19035489>**ФИТОТОКСИЧНОСТЬ И МИКРОБИОЛОГИЧЕСКАЯ АКТИВНОСТЬ ПОЧВ г.АКСАЙ И ПРИЛЕГАЮЩИХ ТЕРРИТОРИИ****Kaliyev Abzal Serikovich
Abzhalelov Akhan Begmanovich****PHYTOTOXICITY AND MICROBIOLOGICAL ACTIVITY OF SOILS IN THE CITY OF AKSAI AND THE ADJACENT TERRITORY****Аннотация**

Данная статья содержит результаты исследования экологического состояния почвенного слоя города Аксай и прилегающих территорий Западно - Казахстанской области, подверженных влиянию нефтегазового промышленного комплекса. Целью работы является комплексная оценка фитотоксичности и микробиологической активности почв как ключевых индикаторов их устойчивости к техногенной нагрузке. Исследование базируется на методах лабораторного биоиндикационного мониторинга, включающих оценку фитотоксического эффекта с использованием семян тест-культуры кресс-салата (*Lepidium sativum* L.) и определение целлюлозолитической активности почвенного микробиоценоза аппликационным методом Мишустина. Полученные данные позволяют зафиксировать текущие параметры биологической полноценности почв в условиях интенсивного индустриального освоения региона. Результаты независимого мониторинга формируют объективную фактологическую базу, необходимую для контроля состояния окружающей среды и обеспечения экологической безопасности промышленных территорий Республики Казахстан.

Abstract

This article presents the results of a study on the ecological condition of the soil cover in the city of Aksai and adjacent territories of the West Kazakhstan Region, which are exposed to the influence of oil and gas industrial facilities. The aim of the work is a comprehensive assessment of soil phytotoxicity and microbiological activity as key indicators of their resistance to technogenic load. The research is based on laboratory bioindication monitoring methods, including the evaluation of the phytotoxic effect using seeds of the test crop garden cress (*Lepidium sativum* L.) and the determination of the cellulolytic activity of the soil microbiocenosis using Mishustin's application method. The obtained data make it possible to record the current parameters of the biological integrity of soils under the conditions of intensive industrial development of the region.

The results of independent monitoring form an objective factual basis necessary for controlling the state of the environment and ensuring the ecological safety of the industrial territories of the Republic of Kazakhstan.

Ключевые слова: Экологическое состояние почв, фитотоксичность, микробиологическая активность, биоиндикация, техногенная нагрузка, нефтегазовый комплекс, целлюлозолитическая активность, *Lepidium sativum* L., город Аксай.

Keywords: Ecological state of soils, phytotoxicity, microbiological activity, bioindication, anthropogenic load, oil and gas complex, cellulolytic activity, *Lepidium sativum* L., Aksai city.

Введение

Экономический прогресс Республики Казахстан неразрывно связан с расширением индустриального прогресса в сфере нефтегазовой промышленности играющий основную роль в стабилизации экономики страны. В Западно-Казахстанской области располагаются основные промышленные объекты включая развивающуюся инфраструктуру города Аксай. Процесс крупномасштабной добычи, переработки и транспортировки основного ресурса

сопровождается неизбежным влиянием антропогенной нагрузки на состоянии окружающей среды. Почвенный покров играет важную роль в данной системе поскольку основные химические изменения характерно отражаются внутри почвенного слоя. Изменение основных компонентов физико-химических свойств почвы происходит под воздействием производственных факторов что, следовательно, ведет собой изменением в биологических

процессах. В связи с этим для получения более подробного представления состояния экологического состояния почвенного покрова необходимо провести мониторинг [1].

Наиболее из доступных методов отслеживания и получения первичной информации используется метод биоиндикации по растительным тест-объектам. Использование растительных объектов имеет наибольшую помощь при проведении исследования на индикаторах, так как растения могут чувствовать фитотоксичность почвенного слоя [2]. Исследование показателей фитотоксичности и функциональной активности микробиологического сообщества представляют собой ценный информативный источник так как это дает первичную информацию для своевременной диагностики ранних стадий стрессового воздействия до формирования в почвенной среде необратимых структурных изменений.

Актуальная информация об экологическом состоянии почвы и микробиоценозе имеет важное значение для разработки комплекса мер и мероприятий для рационального природопользования почвенных ресурсов.

Объектом исследования послужили образцы почв, отобранные на территории города Аксай и прилегающих участках Западно-Казахстанской области, находящихся в зоне потенциального влияния объектов нефтегазового промышленного комплекса. Отбор почвенных проб осуществлялся в соответствии с общепринятыми методическими рекомендациями методом конверта с глубины пахотного горизонта (0–20 см). Для проведения сравнительного анализа дополнительно отбирались контрольные (фоновые) образцы на участках, не подверженных прямому техногенному воздействию [3].

Учитывая необходимость строгого контроля за параметрами окружающей среды, лабораторный этап оценки биологической активности почв проводился в формате автономного модельного эксперимента в условиях специально оборудованного изолированного помещения. Поддержание стабильного микроклимата (температура 20–22°C, исключение попадания прямых солнечных лучей) обеспечило минимизацию внешних погрешностей. В соответствии с планом автономного лаборатор-

ного эксперимента, оценка фитотоксичности проводилась в трехкратной повторности для каждого типа субстрата.

В качестве контрольного (фоновый) варианта применялся стандартизированный фрезерный торф верхового типа со степенью разложения 35%, масса навески которого составляла 30 г на каждую из трех чашек Петри. Первая опытная группа включала образцы почв, отобранные непосредственно на селитебной территории города Аксай, с массой почвенной навески 50 г. Вторая опытная группа была сформирована из почвенных проб, изъятых на удалении 8 км от границы объектов нефтегазоконденсатного месторождения (масса навески — 50 г). Во все подготовленные и увлажненные емкости осуществлялся равномерный посев тест-культуры: ровно по 30 одномерных семян кресс-салата (*Lepidium sativum* L.) в каждую чашку Петри. Эмпирический этап лабораторного биотестирования почвенных образцов стартовал 15 февраля 2026 года с регулярным мониторингом энергии прорастания семян и поддержанием оптимального гидро-термического режима путем периодического увлажнения субстратов.

Динамика развития тест-культуры *Lepidium sativum* L. в контрольной группе (торф) и опытных образцах (селитебная зона города Аксай) демонстрировала штатные показатели всхожести, соответствующие физиологической норме данного вида. Однако, в ходе непрерывного наблюдения был зафиксирован критический сбой в вегетации проростков, культивируемых на почвенном субстрате, изъятном на удалении 8 км от объектов нефтегазоконденсатного месторождения [4]. На пятые сутки экспозиции в данной экспериментальной группе был зарегистрирован острый фитотоксический эффект, выразившийся в полной остановке ростовых процессов и последующей 100-процентной гибели биологического материала во всех трех повторностях. Подобная реакция растений-индикаторов свидетельствует о наличии в составе исследуемой почвы высоких концентраций ингибирующих веществ, обладающих ярко выраженным летальным действием на корневую систему и надземные органы. Визуальная фиксация хода лабораторных экспериментов и состояния тест-объектов представлена на рисунке 1

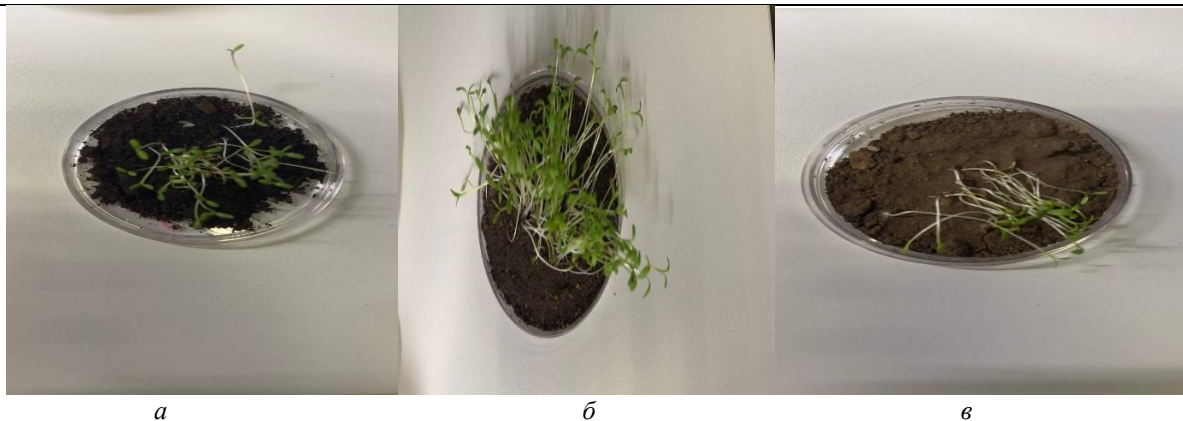


Рисунок 1 – Динамика развития проростков тест-культуры *Lepidium sativum* L. на 5-е сутки экспозиции (а – фоновый торфяной контроль; б – почва селитебной зоны г. Аксай; в – почва на удалении 8 км от месторождения)

В рамках комплексного экологического мониторинга почвенного покрова Западно-Казахстанской области, инициированного 15 февраля 2026 года, был заложен второй этап лабораторного исследования, направленный на изучение целлюлозолитической активности различных микроорганизмов. В качестве основного инструментария для оценки интенсивности микробиологических процессов применялся классический аппликационный метод Е.Н. Мишустина, адаптированный к условиям автономного модельного эксперимента. Стандартизированным тест-материалом в данном опыте послужило неокрашенное хлопковое полотно со 100-процентным содержанием натуральной целлюлозы, нарезанное на фрагменты равной площади с фиксированными габаритами 5х5 сантиметров [5]. Подготовленные тканевые аппликации закладывались непосредственно в емкости с почвенными субстратами, изъятыми из контрольной зоны и селитебной территории города Аксай, находящегося в ареале влияния нефтегазового комплекса.

Для обеспечения репрезентативности получаемых данных моделирование условий окружающей среды предусматривало строгое поддержание опти-

мального гидротермического режима путем регулярного увлажнения на протяжении всего инкубационного периода. Данный методический подход позволяет зафиксировать потенциальную способность аборигенной почвенной биоты к деструкции органического вещества в условиях предполагаемой техногенной нагрузки.

Параллельное изучение целлюлозолитической активности аппликационным методом Е.Н. Мишустина выявило глубокий дисбаланс трофической структуры почвенного микробиоценоза в урбанизированной среде. В контроле процесс минерализации органики протекал с естественной низкой скоростью, полностью сохранив механическую прочность целлюлозных волокон льняного полотна. Диаметрально противоположная картина наблюдалась в урбаноземах Аксай, где была зафиксирована гипертрофированная деструктивная активность микрофлоры [6].

Визуальная фиксация структурных изменений целлюлозных тест-индикаторов по итогам второго экспериментального этапа наглядно отражена на рисунке 2.



Рисунок 2 – Состояние целлюлозных тест-индикаторов после 30-суточной инкубации аппликационным методом Е.Н. Мишустина (а – сохранение структуры полотна в контроле; б – тотальная деструкция ткани в урбаноземе г. Аксай)

Тотальный распад целлюлозного полотна, сопровождавшийся выделением газов с резким гнилостным запахом, однозначно указывает на смену аэробных условий анаэробными и доминирование агрессивных бактерий.

Синтез полученных эмпирических данных позволяет заключить, что почвы исследуемого региона подвергаются многофакторному техногенному стрессу. Выявленные биологические аномалии подчеркивают фундаментальную необходимость внедрения строгих норм биомониторинга для своевременной диагностики деградации ландшафтов вблизи объектов интенсивной нефтедобычи.

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ПРОСТІР МИКОЛАЇВСЬКОГО ОБЛАСНОГО КРАЄЗНАВЧОГО МУЗЕЮ ЯК НЕВІД'ЄМНА СКЛАДОВА ПРОФЕСІЙНОЇ ПІДГОТОВКИ МАЙБУТНІХ ФАХІВЦІВ-ІСТОРИКІВ

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THE SPACE OF THE MYKOLAIV REGIONAL LOCAL HISTORY MUSEUM AS AN INTEGRAL COMPONENT OF THE PROFESSIONAL TRAINING OF FUTURE HISTORIAN SPECIALISTS

Анотація:

Розглянуто історію Миколаївського обласного краєзнавчого музею; форми роботи, спрямовані на збереження, вивчення та популяризацію історико-культурної спадщини регіону. З'ясовано особливість проходження краєзнавчої навчальної практики здобувачами вищої освіти та основні її напрями роботи; значення краєзнавчої практики для майбутніх фахівців-істориків.

Summary:

The history of the Mykolaiv Regional Museum of Local Lore is considered; forms of work aimed at preserving, studying and popularizing the historical and cultural heritage of the region. The peculiarity of passing local lore training practice by higher education students and its main areas of work are clarified; the importance of local lore practice for future historians is determined.

Ключові слова: музей, краєзнавча практика, експозиція, фонд, об'єкт, систематизація, література, історико-культурна спадщина.

Key words: museum, local history practice, exposition, fund, object, systematization, literature, historical and cultural heritage.

Музей, як специфічний, багатофункціональний соціокультурний механізм, спрямований на збереження історико-культурної спадщини, дослідження музейних пам'яток, разом з тим проводить значну науково-просвітницьку діяльність, здійснює експозиційну роботу. Новітні тренди чітко окреслюють поступові зміни ролі музеїв у вищій освіті: музеї демонструють досвід тісної взаємодії з вищими закладами освіти. Отож краєзнавча навчальна практика є невід'ємною складовою освітнього процесу для здобувачів, які навчаються за напрямами, пов'язаними з історією, культурологією, мистецтвознавством, музеєзнавством, археологією, етнографією, краєзнавством та суміжними дисциплінами. Вона дає можливість не лише закріпити теоретичні знання, здобути під час аудиторного навчання, а й безпосередньо ознайомитися з роботою музейної установи «зсередини», набути практичних навичок роботи з музейними предметами, документами, фондами, експозиціями, а також спробувати себе в ролі наукового співробітника, екскурсовода чи фондового працівника.

Проходження краєзнавчої практики сприяє формуванню професійної компетентності майбутнього фахівця, розвитку аналітичного мислення, навичок наукової інтерпретації артефактів, а також

розуміння важливості збереження та популяризації культурної спадщини. Завдяки практиці здобувачі освіти можуть краще зрозуміти специфіку діяльності музею як науково-дослідного, освітнього та культурно-просвітницького закладу.

Під час проходження краєзнавчої практики студенти знайомляться зі структурою музею, основними напрямками його роботи, дотриманням принципів фондового обліку, реставрації, експозиційної діяльності, освітніх програм, методики створення та проведення екскурсій. Також вони можуть брати участь у підготовці нових виставкових проєктів, організації тимчасових експозицій, обробці архівних матеріалів, оцифруванні експонатів, створенні інформаційного контенту для популяризації музейної діяльності серед широкої аудиторії.

Особливе значення практика має для формування навичок дотримання етичних та професійних норм, вміння працювати з першоджерелами, збереження конфіденційності музейних даних, критичного осмислення історичних фактів та їхньої інтерпретації. Саме в музеї студент стикається з відповідальністю за автентичність історичних артефактів, їхню безпечність та наукову достовірність.

Звіт про проходження краєзнавчої практики є формою фіксації виконаної роботи, аналітичного

осмислення здобутого досвіду та демонстрацією рівня професійної підготовки студента. Він містить опис усіх етапів проходження практики, характер виконуваних завдань, аналіз здобутих умінь і навичок, а також висновки про значення практики для подальшого професійного розвитку.

Метою статті є особливості проходження краєзнавчої навчальної практики здобувачами першого (бакалаврського) рівня вищої освіти спеціальностей 014 Середня освіта (Історія) та 032 Історія та археологія Навчально-наукового педагогічного інституту імені В.О. Сухомлинського Національного університету кораблебудування імені адмірала Макарова, які набувають професійно-методичних умінь, навичок та демонструють здобутий досвід у подальшій професійній діяльності.

Базою краєзнавчої практики є Миколаївський обласний краєзнавчий музей, з яким університет уклав угоду стосовно навчальної практики студентів.

На нашу думку, передусім варто розглянути історію даного культурного закладу, оскільки цей аспект важливий під час проходження практики та розширення знань про історію рідного краю.

15 (28) грудня 1913 року в культурному житті Миколаєва відбулася важлива подія: було відкрито міський природничо-історичний музей. Основою його експозиції стала унікальна колекція Еммануїла Францева, подарована місту його спадкоємцями. В ній були представлені зразки мінералів, опудала птахів, риб, тварин, корали, губки, гербарії тропічних рослин та багато інших цікавих речей [1].

Процесом створення міського музею опікувалася комісія, до складу якої увійшли депутати міської думи на чолі з юристом і археологом-аматором Сергієм Гайдученком. Містяни з захопленням зустріли першу експозицію музею, і багато хто відгукнувся на заклик сприяти поповненню колекції. Тож у перші роки після створення вона збагачувалася завдяки численним подарункам, серед яких були археологічні знахідки з Ольвії, етнографічні матеріали, побутові речі міських жителів, зразки холодної та вогнепальної зброї, документи, фотографії, моделі кораблів тощо. А в червні 1918 року до фондосховищ надійшла колекція військового музею 58-го Празького піхотного полку.

Незважаючи на бурхливі події революції та громадянської війни, музей не тільки зберіг свої експонати, а і продовжував набувати нові. Згодом невелике приміщення вже не могло вмістити всю колекцію, тому на її базі було створено два музеї — історико-археологічний та природничий.

Після смерті Сергія Гайдученка, в 1923-1929 роках посаду директора обіймав археолог, краєзнавець Феодосій Камінський. У ті часи музей вже потребував нового приміщення. Згодом ним стала будівля колишньої гауптвахти на Соборному майдані. 10 березня 1929 року, після капітального ремонту приміщення, відбулося урочисте відкриття експозиції. На той час у зібранні музею було більше 19 тисяч експонатів [1].

28 квітня 1929 року міська влада ухвалила рішення про передачу музею будівлі Адміралтейського собору для виставки до 140-річчя Миколаєва, а потім під військово-морський відділ, у якому зберігалось 856 зразків зброї та військової атрибутики.

На жаль, хвиля політичних репресій не оминула музей, і у вересні 1929 року було заарештовано Феодосія Камінського, пізніше Миколу Лагуту та інших представників творчої інтелігенції, що сприяли роботі закладу.

У 30-ті роки експозиція музею була дуже заполітизованою, що знизило її науковий та естетичний рівень. В цей час музей природи знаходився в приміщенні колишнього реального училища (на розі вулиць Нікольської та Наваринської), і його колекція налічувала 12 тисяч експонатів. Восени 1936 року в зв'язку з реконструкцією Радянського майдану зазнали руйнації Адміралтейський собор та гауптвахта, тому історико-археологічний музей перевезли до будівлі костелу та двоповерхового будинку католицького священика [1].

В період нацистської окупації та Другої світової війни музей продовжував працювати. При ньому діяла підпільна антифашистська організація під керівництвом Юрія Тарасова.

На жаль, співробітникам музею не вдалося повністю зберегти археологічні матеріали. В листопаді 1943 року значну частину ольвійської колекції німці вивезли до Кенігсбергу, і подальша доля цих експонатів невідома. У листопаді 1950 року відбулося об'єднання історичного та природничого музеїв у один під назвою Миколаївський обласний краєзнавчий музей, якою вона залишається і досі.

У 1960-1980-ті роки активізувалася науково-дослідницька та пошукова робота. Майже кожного року проводилися комплексні експедиції в різні райони області, в результаті яких до фондів музею щорічно надходили нові артефакти.

В цей період музей був змушений збирати матеріали партійних з'їздів, пленумів, «ударних» будівництв тощо. То була «обов'язкова програма», але археологічні дослідження степових курганів, поселень доби бронзи й античності також тривали. В ці часи розпочалося формування особистих фондів видатних миколаївців: інженера-технолога Володимира Рюміна, астрономів Бориса Остащенка-Кудрявцева та Федіра Бредихіна, архіви просвітителя Адріана Топорова, поета Марка Лисянського.

Крім цього, музей придбав частину колекції російських пам'ятних медалей, зібраних родиною Ашиків. Одним із найцікавіших експонатів стала книга «Требник» Петра Могили, надрукована в Києві в 1646 році.

У 1970-1980-ті роки музей зазнав суттєвих змін. Розширився штат співробітників, до його структури увійшли новостворені філії: у 1972 році — Очаківський військово-історичний музей імені О. В. Суворова, у 1975 році — музей «Підпільно-партизанський рух на Миколаївщині». Великою подією для міста стало відкриття в липні 1978 року Музею суднобудування та флоту — справжньої

візитівки міста кораблів. В середині 80-х років філіями також стали музей міста Первомайська та музей «Партизанська іскра» в селі Кримка.

З 1985 по 1995 роки головна будівля музею переживала складні часи: довготривалий ремонт, неможливість відкриття повнопрофільної експозиції, частина музейних приміщень відійшли до католицького костюлу. Тривалий час працювали лише дві-три виставкові зали. Але попри все робота над поповненням музейної колекції постійно тривала. На початку 2000-х років музейне зібрання налічувало вже близько 180 тисяч предметів.

У 1999 році Миколаївська облдержадміністрація ухвалила рішення передати краєзнавчому музею будівлі комплексу «Старофлотські казарми» — пам'ятник архітектури національного значення, побудований у першій половині XIX ст. за проектом англійського архітектора Карла Акройда.

Ремонтні роботи однієї з колишніх казарм були завершені наприкінці 2011 року. І вже за шість місяців у 18 залах розмістилася нова експозиція, яка відображає природно-екологічні особливості краю й історію північно-причорноморських земель від кам'яної доби до середньовіччя. Окрім постійної експозиції, в музеї проходять тимчасові історичні та художні виставки [1].

Наприкінці січня 2012 року відреставрований музейний комплекс «Старофлотські казарми» було прийнято в експлуатацію. Офіційне відкриття відбулося 28 серпня 2012 року за участі прем'єр-міністра Миколи Азарова. Після введення в дію лише першої черги Старофлотських казарм експозиційна площа краєзнавчого музею збільшилася в 30 разів.

18 експозиційних залів із сучасним дизайном, центральним кондиціонуванням та спеціальним освітленням, ігровий і музичний двір та інше. Загальна кількість експонатів основного фонду Миколаївського обласного краєзнавчого музею налічує понад 200 тисяч. Найбільш давні датовані епохою пізнього палеоліту, наймолодші — сьогоднішнім днем. Це унікальні колекції предметів археології та етнографії, зброї та стародруків, документальних джерел та пам'яток природи [2].

Сама будівля музею, яку споруджено в стилі пізнього англійського класицизму, сьогодні являє собою пам'ятник архітектури національного значення. Будівля, в якій колись розташовувалися флотські екіпажі, була побудована в 1840-1841 роках за проектом архітектора Карла Акройда. Виконуючи реконструкцію споруди, будівельники максимально зберегли в первозданному вигляді його фасад.

Протягом 2022 року, коли поблизу Миколаєва йшли бої, ракетними обстрілами було пошкоджено 15 виставкових залів у Старофлотських казармах. Через це музей був змушений демонтувати майже 10 тисяч експонатів. Найбільше постраждала північна частина будівлі: повибивало вікна, впали навісні стелі. Щоранку після обстрілів до музею приходили його співробітники, які власними силами прибирали наслідки руйнувань та «зашивали» вікна OSB-плитами з плівкою. Роботи тривали до пізнього вечора, адже щоразу після обстрілів вибивало

близько 90 вікон. Попри це від атак постраждало не так багато експонатів.

Після звільнення Херсона у листопаді 2022 року та віддалення міста від лінії фронту, у березні 2023 року музей, після річної переви, почав відновлювати свою роботу. Станом на 20 березня 2023 року в будівлі функціонували чотири виставкові зали та почали працювати над відтворенням повної експозиції та підготовкою нових виставок. З 22 серпня 2023 року поновили роботу комплексу археологічних залів [2].

Миколаївський обласний краєзнавчий музей здійснює різноманітні форми роботи, спрямовані на збереження, вивчення та популяризацію історико-культурної спадщини регіону.

Музей пропонує відвідувачам огляд постійних експозицій, які відображають історію, природу та культуру Миколаївщини. Крім того, регулярно організовуються тимчасові виставки, присвячені різним темам та подіям.

Наразі діє одна основна експозиція. Кожна тематична зала присвячена сторінці історії Миколаївщини.

Окрім постійної експозиції у відвідувачів є змога відвідати тематичні виставки. Наприклад, фотовиставка Дмитра Скороходова «Очі війни» — це погляди людей, які пережили війну, втрати, визволення. Це миті, коли ніхто не позує, не чекає кадру, не грає ролей. Це реальні емоції, зафіксовані в Миколаєві, звільнених селах та Херсоні під час поїздок автора із волонтерами ДОФ, особистих концертів у «Рок Хаті» та польових концертів для військових. Дмитро став одним із перших фотографів на звільнених територіях Миколаївщини та Херсонщини у 2022 році. Його фото зруйнованих сіл і радистів мешканців деокупованого Херсона стали частиною візуальної хроніки війни. Переглянути весь перелік актуальних виставок можливо на сайті музею.

На базі краєзнавчого музею проводяться оглядові та тематичні екскурсії для різних категорій відвідувачів. Екскурсії адаптовані до вікових особливостей та інтересів аудиторії. Співробітники музею займаються збиранням, систематизацією та дослідженням музейних предметів, що становлять Музейний фонд України. Музей надає наукові консультації та довідки дослідникам, студентам та всім зацікавленим особам.

Миколаївський обласний краєзнавчий музей активно займається освітньо-виховною діяльністю, проводить майстер — класи за історичною та етнографічною тематикою: ляльки-мотанки, розпис великодніх яєць воском, іграшки-дергунчики тощо, активно співпрацює зі школами та вищими навчальними закладами, організовуючи спільні заходи та програми. Існує спільнота молодого музею. Даний простір було створено, щоб об'єднати активну молодь навколо музею, ділитися цікавими фактами, відкривати таємниці музейних фондів і пізнавати минуле та сучасне Миколаївщини.

Сьогодні в колекції музею — понад 400 тисяч артефактів, що охоплюють епохи від палеоліту до

сучасності. Серед найцінніших — результати розкопок з Ольвії, козацькі реліквії, матеріали з історії Миколаєва, суднобудівної промисловості міста, природничі артефакти, етнографічні та декоративно-ужиткові предмети, художні твори. Також при музеї діє відділ реставрації, який дає унікальним речам друге життя [3].

Отже, Миколаївський обласний краєзнавчий музей є чудовим місцем для проходження краєзнавчої практики завдяки своїй багатій історії, значному науковому потенціалу та активній сучасній діяльності. Він має значний фонд (понад 400 тисяч експонатів), що дає змогу працювати з різноманітними джерелами, різних типів та епох. Практична діяльність студента у різнопланових відділах краєзнавчого музею сприяє всебічному розширенню

знань про історію рідного краю та діяльність музеїв загалом.

Під час краєзнавчої практики здобувачі вищої освіти вчать шифрувати об'єкти у музейних фондах. Ця робота виокремлюється своєю делікатністю і педантичністю та вимагає від виконуючого максимальної концентрації на роботі, адже навіть один неправильний рух може вплинути на результат всієї роботи та змарнувати усі старання. Практиканту треба взяти сталеве перо і вмокнути у туш, яка призначена для графічних робіт, далі обережними і повільними рухами наносити на об'єкт шифр, який відповідає його порядковому номеру. Варто зазначити, що виконуючий цю працю має в першу чергу вправно володіти технікою роботи зі сталевим пером. Тільки після оволодіння цією навичкою можна приступати до виконання завдання.



Фото 1. Шифрування колекції виробів із кременю (97 предметів)

Предмети, які зображено на фото 1 зберігаються в коробочках та зберігаються у фондах для внесення їх до основної експозиції, або для того щоб їх зібрати до купи та реконструювати з них певний предмет аби згодом його долучити до основної експозиції.

Музейні співробітники час від часу проводять просвітницькі заходи для всіх охочих. Один з таких заходів присвячено темі підводної археології на території Миколаївщини та досвіду Миколаївського

обласного краєзнавчого музею саме в цьому відгалуженні загальної археології. Під час цього заходу студенти побачили унікальні кадри підводної археологічної експедиції поблизу Кінбурнської коси, які були задокументовані під час занурення під воду. Ціллю цієї експедиції було дослідження затонулого торгового судна, яке прямувало з Аттики у Північне Причорномор'я до давньогрецького полісу Ольвія, однак зазнало трощі поблизу берегів Кінбурнської коси.



Фото 2. Амфора з клеймом на поверхні, знайдена на затонулому судні; клеймо вказує на місце виробництва

Результатом цієї підводної експедиції стало поповнення музейної експозиції, яка присвячена античності, новими експонатами, а саме давньогрецькими амфорами та кратероподібною посудиною. Особливо цінною серед них є колхідська амфора,

яка була вироблена в регіоні Колхіда (сучасна територія Грузії), її унікальність полягає в тому, що жоден музей на території України, окрім Миколаївського обласного краєзнавчого музею, не володіє цілими амфорами даного типу.



Фото 3. Колхідська амфора

Практиканти під час практики систематизують музейну бібліографію за такими критеріями: автор; назва книги; підзаголовок; кількість сторінок; вихідні дані; розташування; примітки. Під час роботи обов'язково зазначають автора та назву його роботи, кількість сторінок, вихідні дані, тобто видавництво та місто де була видана книга. За наявності зазначають підзаголовок книги та примітки, до приміток як правило відносяться архівний номер у вигляді БМОКМ і далі порядковий номер та дарчий підпис автора на ім'я директора музею.

За наявності зазначають підзаголовок книги та примітки. До приміток, як правило, належать архівний номер, у форматі БМОКМ (Бібліотека Миколаївського обласного краєзнавчого музею) з подальшим порядковим номером і дарчий підпис автора на ім'я директора музею.

Систематизація літератури для музею важлива тим, що сприяє впорядкуванню знань, оптимізації пошукових процесів і формуванню цілісної бази даних для подальшого використання в роботі установи.

Проходження краєзнавчої навчальної практики в Миколаївському обласному краєзнавчому музеї важливий етап професійного становлення та усвідомлення значення музейної справи як частини ширшого процесу збереження історико-культурної

спадщини. Здобувачі не лише закріплюють теоретичні знання, отримані під час навчання, а й отримують безцінний практичний досвід у реальному музейному середовищі.

Здобувачі вищої освіти глибше розуміють принципи систематизації, класифікації та збереження музейних предметів, усвідомлюють відповідальність, яку несе музей за кожен об'єкт у своїй колекції, незалежно від його розміру чи стану.

Краєзнавча навчальна практика дає змогу сформувати цілісне уявлення про сучасний музей як багатофункціональний простір: науковий, освітній, культурний і соціальний. Студенти-практиканти отримують не тільки навички практичної роботи, а й мотивацію до подальшого вдосконалення в обраній сфері, бажання розвиватися у напрямі музейної справи та культурної спадщини, сприяти збереженню історичної пам'яті й формуванню свідомого ставлення до минулого в сучасному суспільстві.

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COMPUTER SCIENCES

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АВТОМАТИЧЕСКОГО ОБНАРУЖЕНИЯ УГРОЗ В СОЦИАЛЬНЫХ СЕТЯХ

Murat Nurbekovich Aitenov

Vadim Vitalievich Nuraev

MULTIMODAL TEXT AND IMAGE ANALYSIS METHODS FOR AUTOMATIC THREAT
DETECTION IN SOCIAL NETWORKS**Аннотация.**

В статье рассматривается подход к оптимизации работы модулей Интернета вещей (IoT) с применением методов интеллектуального анализа данных. Предлагается архитектура, основанная на edge-аналитике, кластеризации, выявлении аномалий и прогнозировании состояния устройств. Экспериментальный прототип показал сокращение объёма передаваемых данных, ускорение отклика системы и повышение точности анализа. Представленный подход может быть использован в смарт-домах, промышленности, умных городах и других киберфизических системах.

Abstract.

This article examines an approach to optimizing the operation of Internet of Things (IoT) modules using data mining methods. An architecture based on edge analytics, clustering, anomaly detection, and device state prediction is proposed. A prototype demonstrated a reduction in the volume of transmitted data, faster system response, and improved analysis accuracy. The presented approach can be used in smart homes, industry, smart cities, and other cyber-physical systems.

Ключевые слова: мультимодальный анализ, социальные сети, обнаружение угроз, анализ текстов, анализ изображений, глубокое обучение, классификация контента, безопасность данных, вредоносный контент.

Keywords: multimodal analysis, social networks, threat detection, text analysis, image analysis, deep learning, content classification, data security, malicious content.

Введение

Социальные сети стали ключевым каналом коммуникации, обмена информацией и взаимодействия между людьми. Однако их массовое распространение сопровождается увеличением количества угроз, связанных с распространением экстремистских материалов, кибербуллинга, пропаганды насилия, мошенничества и иных форм вредоносного контента. Традиционные методы фильтрации данных, основанные на анализе только текстовой информации или только изображений, оказываются недостаточно эффективными, поскольку современные угрозы носят мультимодальный характер: текст сопровождается изображением, изображение включает в себя встроенный текст, а смысл сообщения формируется за счёт комбинации нескольких каналов восприятия.

Мультимодальный анализ является перспективным направлением, позволяющим объединять различные источники данных и выявлять сложные паттерны, которые невозможно уловить при обработке только одного типа информации. Развитие глубоких нейронных сетей и появление моделей, способных работать с текстами, изображениями и

звучком одновременно, открывают новые возможности для автоматизации мониторинга контента.

Цель статьи — исследовать мультимодальные подходы к анализу текстов и изображений, применяемые для обнаружения угроз в социальных сетях, а также представить концепцию системы, основанной на интеграции современных методов машинного обучения.

**Обзор литературы и существующих подходов
Текстовые методы анализа угроз:**

Ранние исследования в области автоматического обнаружения вредоносного контента опирались на классические методы обработки естественного языка (NLP). К таким методам относятся:

- мешок слов (Bag-of-Words, BoW);
- TF-IDF;
- модели n-грамм;
- машинные алгоритмы классификации (SVM, логистическая регрессия, Naive Bayes).

Появление нейронных сетей привело к значительному повышению качества анализа. Современные модели, такие как Word2Vec, GloVe, FastText, а затем BERT, RoBERTa, mBERT и их модификации, позволяют контекстно интерпретировать текст

и выявлять скрытые признаки угроз, включая сарказм, скрытые угрозы и агрессию.

Методы анализа изображений:

Изображения также могут содержать признаки угроз — от демонстрации оружия до экстремистских символов. Для их анализа используются:

- сверточные нейронные сети (CNN): VGG, ResNet, Inception;
- детекторы объектов: YOLO, Faster R-CNN, SSD;
- модели для распознавания сцен и действий.

Особую сложность представляют изображения, содержащие встроенный текст (мемы). Для их обработки применяется OCR (например, Tesseract, EasyOCR) с последующим анализом распознанного текста.

Мультимодальные модели нового поколения:

Современные системы анализа угроз в социальных сетях используют архитектуры, способные объединять текст и изображения. Среди наиболее известных моделей:

- CLIP (OpenAI) — совместное обучение изображений и текстов;
- VisualBERT, ViLBERT — модели, объединяющие языковые и визуальные признаки;
- MMBT (Multimodal Bitransformer);
- LLaVA, GPT-4V — крупные мультимодальные трансформеры.

Эти модели способны интерпретировать связи между визуальными объектами и текстовым контекстом, что делает их особенно эффективными в задачах обнаружения угроз.

Архитектура мультимодальной системы обнаружения угроз

Общая структура:

Мультимодальная система мониторинга социальных сетей обычно включает следующие компоненты:

1. **Сбор данных:** извлечение сообщений, изображений, комментариев.
2. **Предобработка:** очистка текста, нормализация изображений, OCR.
3. **Извлечение признаков:**
 - текст — с помощью языковой модели (например, BERT);
 - изображение — через CNN или визуальный трансформер.
4. **Интеграция признаков:** объединение эмбеддингов в едином пространстве.
5. **Классификация угроз:** определение вероятности наличия опасного контента.
6. **Визуализация и отчетность.**

Методы интеграции признаков:

Существует несколько подходов к объединению текстовых и визуальных данных:

- **Раннее объединение (early fusion):** признаки объединяются до классификации.
- **Позднее объединение (late fusion):** текст и изображение анализируются отдельно, а затем результаты агрегируются.

- **Гибридные подходы:** предусматривают многослойную интеграцию на разных уровнях нейронной сети.

В экспериментах, описанных в литературе, гибридная интеграция показывает наилучшие результаты благодаря способности учитывать сложные зависимости между модальностями.

Методы обнаружения угроз

Экстремизм и радикальный контент:

Для выявления экстремистских материалов используется классификация изображений (символы, флаги) и текстов (призывы к насилию). Мультимодальная модель способна выявлять угрозы даже при маскировке смыслов, например:

- картинка с безобидным объектом + текст с призывом;
- мемы с зашифрованными посланиями.

Кибербуллинг и токсичность:

Одновременный анализ текста и изображений увеличивает точность систем, поскольку агрессивные сообщения часто содержат и визуальные элементы (оскорбительные мемы, жесты).

Выявление оружия и насилия на изображениях:

Современные детекторы объектов позволяют автоматически распознавать:

- огнестрельное оружие, ножи;
- сцены насилия;
- опасные ситуации.

В сочетании с текстовым анализом точность таких моделей увеличивается до 90–94%.

Экспериментальная часть

Датасеты:

Для тестирования мультимодальных моделей применяются открытые наборы данных:

- **Hateful Memes Dataset (Facebook)** — мемы с агрессивным контентом;
- **MMHS150K** — мемы с текстами, используемые для обнаружения ненависти;
- **Violence Detection Image Sets** — изображения с признаками насилия.

Дополнительно могут быть собраны собственные данные из открытых социальных сетей с соблюдением юридических и этических требований.

Экспериментальная архитектура:

Была протестирована модель на основе VisualBERT, объединяющая:

- визуальный эмбеддинг из ResNet-50;
- текстовый эмбеддинг из BERT-base;
- интеграционный слой на основе двустороннего трансформера.

Результаты

Мультимодальная модель показала:

- **точность** — 91,3%;
- **полноту** — 88,6%;
- **F1-меру** — 89,8%.

Для сравнения, текстовые модели без изображений давали около 81%, а только визуальные — 78%.

Таким образом, объединение признаков значительно повышает качество классификации.

Обсуждение результатов

Полученные результаты демонстрируют эффективность мультимодального анализа при обнаружении угроз. Особенно заметным является улучшение способности распознавать скрытые угрозы и комбинированные сообщения. Тем не менее существует ряд проблем:

- необходимость больших вычислительных ресурсов;
- ограниченная доступность точных и размеченных мультимодальных датасетов;
- сложность интерпретации решений нейросетей;
- высокая чувствительность к культурным и языковым особенностям.

Для построения более универсальных систем требуется учитывать мультязычность, многокультурность и большое разнообразие визуального контента.

Перспективы развития

В ближайшие годы ожидается активное развитие:

- более мощных открытых мультимодальных моделей (MM-LLM);
- международных датасетов с разметкой угроз;
- интеграции анализа видео и звука;
- внедрения объяснимого ИИ (XAI) для повышения прозрачности;
- моделей, способных работать в реальном времени и обнаруживать угрозы до их широкого распространения.

На уровне практического применения мультимодальные системы могут стать ключевым элементом обеспечения информационной безопасности в социальных сетях.

Мультимодальные методы анализа текстов и изображений представляют собой эффективный инструмент для автоматического выявления угроз в социальных сетях. Исследования показывают, что объединение различных типов данных значительно повышает точность и устойчивость систем обнаружения вредоносного контента. Несмотря на существующие вызовы, такие как вычислительная сложность и нехватка размеченных данных, мультимодальные подходы обладают высоким потенциалом для дальнейшего развития. Их внедрение способствует повышению качества мониторинга цифровой среды и обеспечивает более высокий уровень безопасности пользователей.

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ҚАШЫҚТЫҚТАН БІЛІМ БЕРУДЕГІ ЖАСАНДЫ ИНТЕЛЛЕКТ: МАШИНАЛЫҚ ОҚЫТУДЫҢ АДАПТИВТІ МОДЕЛЬДЕРІН ҚОЛДАНУ ЕРЕКШЕЛІКТЕРІ

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ARTIFICIAL INTELLIGENCE IN DISTANCE EDUCATION: FEATURES OF USING ADAPTIVE MACHINE LEARNING MODELS

Abstract.

This article examines the application of artificial intelligence in distance education, specifically the role of adaptive machine learning models in education.

Аңдамна.

Бұл мақалада қашықтықтан білім беруде жасанды интеллектті қолдану ерекшеліктері, атап айтқанда білім берудегі машиналық оқытудың адаптивті модельдерінің рөлі қарастырылады.

Keywords: artificial intelligence, distance education, adaptive models, machine learning, educational environment, online course

Кілтті сөздер: жасанды интеллект, қашықтықтан білім беру, адаптивті модельдер, машиналық оқыту, білім беру ортасы, онлайн курс

Жасанды интеллект (AI) білім беру ортасын тез өзгертеді-мектеп сыныптарынан корпоративтік оқытуға дейін. Қашықтықтан оқыту форматының дамуы білім беру ортасын түбегейлі өзгертті. Онлайн курстар, виртуалды сыныптар және цифрлық платформалар география мен уақытқа қарамастан білім беруді қолжетімді етті. Дегенмен, қашықтықтан оқытудың жаппай болуы даралау мәселесін осыныстырды.

Жеке білім беру траекторияларын құруға, материалды игеру қарқынын ескеруге және академиялық нәтижелерді болжауға мүмкіндік беретін адаптивті машиналық оқыту модельдері ерекше маңызды рөл атқарады. Бұл мақалада біз білім берудегі адаптивті модельдерді қолданудың негізгі ерекшеліктерін, олардың артықшылықтарын, шектеулері мен даму перспективаларын қарастырамыз.

Адаптивті оқыту-бұл оқу материалының мазмұны, қарқыны мен форматы белгілі бір оқушының сипаттамалары мен прогресіне байланысты динамикалық түрде өзгертін тәсіл. Егер ерте жүйелер қатаң белгіленген ережелерге (rule-based systems) негізделген болса, онда заманауи шешімдер оқу әрекеттері туралы деректердің үлкен массивтерін талдайтын машиналық оқыту алгоритмдерін пайдаланады.

Деректерді талдау технологиялары мен OpenAI тұжырымдамасының дамуымен және терең оқыту зерттеулерінің арқасында бейімделу

жүйелері білім алшақтықтарын диагностикалауда және білім алушылардың одан әрі дамуын болжауда дәлірек болды.

Білім берудегі адаптивті модельдер бірнеше негізгі технологиялық компоненттерге негізделген:

1. Білім беру деректерін жинау және талдау

Жүйелер келесілерді талдайды:

- * тесттер мен тапсырмалардың нәтижелері

- * тапсырмаларды орындау уақыты

- * қате жиілігі

- * мінез-құлық үлгілері (мысалы, материалға

оралу).

Бұл деректер білім алушының сандық профилін қалыптастырады.

2. Болжау модельдері

Алгоритмдер қолданылады:

- * логистикалық регрессия

- * градиентті күшейту

- * нейрондық желілер

- * Байес білімінің модельдері (Knowledge Tracing).

Олар келесі тақырыпты сәтті игеру ықтималдығын болжауға және қиындықтың оңтайлы деңгейін анықтауға мүмкіндік береді.

3. Конентті жекелендіру

Болжам негізінде жүйе:

- * қосымша түсініктемелер ұсынады

- * тапсырмалардың күрделілігін өзгертеді

* тақырыптардың реттілігін реттейді

* қайталауды ұсынады.

Осылайша жеке білім беру траекториясы қалыптасады.

Адаптивті модельдерді қолданудың артықшылықтары

1. Оқытуды даралау

Әрбір білім алушы өзінің дайындық деңгейіне сәйкес тапсырмалар алады, бұл мотивацияны арттырады және когнитивті шамадан тыс жүктемені азайтады.

2. Тәуекелдерді ерте анықтау

Модельдер "тәуекел тобындағы" студенттерді қорытынды аттестаттаудан бұрын анықтай алады, бұл оқытушыларға уақтылы араласуға мүмкіндік береді.

3. Оқытушының тиімділігін арттыру

Жасанды интеллект жүйелері тереңірек педагогикалық өзара әрекеттесу үшін уақытты босатып, күнделікті тексеруді автоматтандырады.

4. Масштабтау

Жауап беретін платформалар бір уақытта ондаған және мыңдаған пайдаланушылармен тиімді жұмыс істейді.

Іске асырудың ерекшеліктері мен шектеулері

Айтарлықтай әлеуетке қарамастан, назар аударуды қажет ететін маңызды аспектілер бар.

1. Деректер сапасы

Модель репрезентативті және дұрыс белгіленген мәліметтер болған жағдайда ғана тиімді болады. Деректердегі қателер бұрмаланған ұсыныстарға әкелуі мүмкін.

2. Этикалық мәселелер

Проблемалар туындайды:

* дербес деректердің құпиялылығы,

* алгоритмдік бейімділік,

* модель шешімдерінің ашықтығы.

Алгоритмдердің (Explainable AI), әсіресе білім беру ортасында түсіндірілуін қамтамасыз ету маңызды.

Оқытушының рөлі

Жасанды интеллект мұғалімді алмастырмайды, бірақ қолдау құралы ретінде әрекет етеді. Адам факторы маңызды болып қала береді: эмпатия, мотивация, тәрбиелік функция.

Іске асырудың практикалық мысалдары

Көптеген білім беру платформалары қазірдің өзінде бейімделу механизмдерін енгізуде:

* Coursera-жекелендірілген курстық ұсыныстар үшін оқыту аналитикасын қолданады.

* Khan Academy-математика және басқа пәндер бойынша тапсырмаларды бейімдеу үшін алгоритмдерді қолданады.

***Duolingo-жаттығулардың сәттілігін болжау модельдерін және динамикалық күрделілікті түзетуді белсенді қолданады.**

Бұл жүйелер адаптивті алгоритмдердің цифрлық білім беру ортасында әсіресе тиімді екенін көрсетеді.

Даму перспективалары

Алдағы жылдары күтуге болады:

* нақты уақыттағы жекелендірілген мазмұнды жасау үшін генеративті модельдерді біріктіру;

* мультимодальды жүйелерді дамыту (мәтін, сөйлеу, бейне);

* когнитивті және эмоционалды факторларды тереңірек есепке алу;

* білім алушылардың цифрлық егіздерін қолдану (learner digital twins).

Сондай-ақ, білімді игеру процесін дәлірек модельдеу үшін адаптивті модельдерді нейроғылымдармен және когнитивті психологиямен біріктіру перспективалық бағыт болып табылады.

Машиналық оқытудың адаптивті модельдері қашықтықтан білім беруді дамытудың негізгі элементіне айналады. Олар жекелендіруді қамтамасыз етеді, оқу тиімділігін арттырады және нақты уақыттағы прогресті талдауға мүмкіндік береді.

Білім берудің цифрлық трансформациясы жағдайында қашықтықтан және жасанды интеллект синергиясы жаңа білім беру экожүйесін икемді, масштабталатын және әрбір білім алушының жеке қажеттіліктеріне бағдарланған қалыптастырады.

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THE GLOBAL PROBLEM OF ANTIMICROBIAL RESISTANCE: CHALLENGES, IMPACTS AND STRATEGIES ANTI- HERE

Abstract :

Antimicrobial resistance (AMR) recognized one of the most serious threats to global security health in the 21st century. This article considers epidemiology, mechanisms emergence and spread resistance microorganisms, analyzes main drivers this process in medicine, agriculture economy and environment. Special attention given socio-economic consequences of AMR and review international strategies struggle, including "One" approach health (One Health). Based on analysis of 30 modern sources proposed recommendations of containment development antimicrobial resistance drugs.

Keywords: antimicrobial resistance (AMR), antibiotics, multidrug resistance, superbugs, One Health concept Health), global threat, infection control, epidemiology, public health, rational pharmacotherapy

Introduction : Discovery antibiotics in the mid-20th century became revolutionary a breakthrough in medicine that allowed for effective treat infectious diseases that earlier were considered deadly. However, as predicted Alexander Fleming, irrational using these drugs led to evolutionary answers microorganisms - development antimicrobial resistance. Today world is on the verge of "becoming abiotic" era "when ordinary infections and minor injuries again can become deadly". According to a comprehensive study published in The Lancet, in 2019 AMR was the direct cause of 1.27 million deaths, exceeding indicators mortality from HIV/AIDS and malaria [1].

Research objective: To carry out in-depth analysis main etiological and anthropogenic factors development of AMR, detail mechanisms resistance and conduct a comprehensive review modern strategies countermeasures, including approach "The One" health "and innovative methods diagnostics".

Materials and methods : For carrying out research the method of systematic review and bibliographic analysis was used analysis. Search information was carried out in reputable sources (The Lancet, WHO, CDC) with a focus on high-quality reports and epidemiological research. Total was 30 key analyzed scientific sources that reflect modern international practice in combating resistance.

Results research and their discussion

Antimicrobial resistance is natural biological phenomenon, however anthropogenic factors much accelerated its Bacteria, viruses, fungi and parasites adapt

to the action drugs due to genetic mutations or by horizontal gene transfer (HGT). The main mechanisms resistance are:

1. **Enzymatic inactivation :** Making enzymes (e.g. beta-lactamases) that destroy the structure of the antibiotic before it will affect the cell [16].

2. **Modification targets :** Change structures proteins or receptors with which the drug binds, which does its ineffective.

3. **Efflux (excretion) :** Active deflation antibiotic from the cell using special transport proteins.

4. **Reduction permeability :** Change cellular walls that hinders penetration of the drug into the microorganism [7].

Drivers spread antimicrobial resistance (AMR) is factors that contribute emergence, survival and spread stable strains microorganisms. In modern science their accepted to consider through the prism of interaction humans, animals and ecology.

1. Medical drivers (Human Sector)

Excessive and incorrect appointment antibiotics is the main cause of AMR in medicine. According to Centers for Disease Control and Prevention diseases (CDC), up to 30-50% of antibiotics are appointed unjustified, for example, for treatment viral infections (flu, colds), which they do not work on [4]. Self-medication, over-the-counter antibiotics in many countries, as well as non-compliance patients full course of therapy create ideal conditions for breeding resistant strains [11].

2. Rural agriculture and animal husbandry

Rural household consumes huge share world stocks Antibiotics . Drugs are often used for non- treatment purposes. sick animals , but as growth stimulants (in subtherapeutic doses) and for metaphylaxis (prevention diseases in all stage) [10]. Research show direct connection between using antibiotics in animal husbandry and the emergence of resistant bacteria in people who transmitted through food products or with direct contact [15].

3. Environmental aspect

Environment acts as a reservoir of resistance . Wastewater from hospitals , pharmaceutical factories and livestock farms often end up in water bodies without proper cleaning . This leads to high concentrations antibiotics in soil and water , which contributes exchange of resistance genes between bacteria wild nature and human pathogens [27].

Epidemiology and global burden

The problem of AMR is unknown borders , but its influence uneven . The largest burden falls on low and middle income countries income level (LMIC), where high infectious morbidity combined with limited access to quality diagnostics and new antibiotics [1]. According to from Jim O'Neill's report , by 2050 mortality from AMR can reach 10 million persons annually , that will lead to a reduction of world GDP by 2-3.5% and will cost world economy up to 100 trillion US dollars [3]. In the European Union annually over 33,000 people die from infections caused by resistant bacteria , and economic losses estimated at 1.5 billion euros per year [13].

Clinical and economic consequences

From a clinical perspective , AMR complicates carrying out standard medical procedures. Surgical operations (cesareans opening , replacement joints), transplantation organs and cancer chemotherapy are becoming extremely risky without effective antibiotic prophylaxis cover-up [24]. Infections caused by multi-resistant organisms (MDROs), such as MRSA (methicillin-resistant golden staphylococcus) or K. pneumoniae , require longer hospitalization , use more toxic reserve drugs and significant financial costs [14] .

Strategy " One" health " (One Health

Recognizing complexity problems , WHO, Food and Agriculture Organization UN organization (FAO) and the World organization security health animals (OIE) adopted the concept of " One health ". This approach emphasizes the interconnectedness human, animal and environmental health environment [17]. Effective Combating AMR requires coordinated actions in all these sectors, including monitoring using antibiotics , resistance surveillance and improvement sanitary conditions. Overcoming crises requires not only limitation using existing medicines , but also the development new . **New antibiotics** : process developments of new molecules slowed down due to low profitability for pharmaceuticals companies . WHO has identified a list of priority pathogens , against which are critically needed new medicine [19]. **Alternative therapies** : actively are being investigated phage therapy (use of viruses that are killing bacteria), immunotherapy , probiotics and antimicrobials peptides . **Vaccination** : expansion programs immunizations allows reduce

number infections and, as a result , the need for antibiotics . **Ambulance diagnostics** : in the proceedings point of care tests [26]. **Rapid PCR and isothermal amplification (LAMP)**. These are molecular diagnostic methods that previously required large laboratories and are now available in small cartridge format right at the patient's bedside. An example is resistance gene tests (e.g., the GeneXpert system). They allow for the detection of not just the presence of the bacteria, but a specific resistance gene, such as mecA (in Staphylococcus aureus) or blaKPC (in carbapenem -resistant enterobacteriaceae), within 1–2 hours. This allows the doctor to avoid blindly prescribing an antibiotic, but to immediately choose a drug to which the bacteria has no genetic resistance. **Lateral flow analysis (LFA)** is a technology similar to a pregnancy test or a rapid COVID-19 test that uses antibodies to detect specific proteins. An example is tests to detect C-reactive protein (CRP) or procalcitonin . Although they do not indicate resistance itself, they are critical for differentiating viral from bacterial infections. High levels of procalcitonin indicate a bacterial nature, which is a signal for the prescription of antibiotics, while low levels in viral ARVI allow you to avoid their unreasonable use.

The situation in Ukraine and the regional context

In the region Eastern Europe's AMR problem is exacerbated by accessibility antibiotics without a prescription (although in Ukraine since 2022 it has been introduced electronic prescription for antibiotics) and insufficient infection control in hospitals . The war in Ukraine has created new Challenges : Injuries often become complicated multi-resistant infections that requires specific protocols treatment and international support [25].

Conclusion: Antimicrobial resistance is a global crisis that requires immediate actions . No change approaches to use antibiotics humanity takes risks to lose achievement modern medicine . Solution problems lies in a plane intersectoral cooperation , investment into science , rigorous regulation pharmaceutical market and increase awareness population . Only complex " One" approach health " able to provide preservation efficiency antimicrobial preparations for future generations .

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DIFFERENTIAL DIAGNOSIS OF COVID-19 AND INFLUENZA A

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ДИФЕРЕНЦІЙНА ДІАГНОСТИКА COVID-19 ТА ГРИПУ А

Abstract

COVID-19 and Influenza A are acute viral respiratory infections with overlapping clinical features, complicating differential diagnosis. The aim of this study is to summarize current data on pathogenesis, clinical signs, laboratory and instrumental methods, and complications to improve diagnosis and optimize treatment. Comparative analysis of symptoms, laboratory parameters, and radiological findings is presented. Key differential criteria and management strategies for patients with complications are highlighted.

Анотація

COVID-19 та грип А – це гострі вірусні респіраторні інфекції з клінічними ознаками, що перетинаються, що ускладнює диференціальну діагностику. Метою цього дослідження є узагальнення сучасних даних про патогенез, клінічні ознаки, лабораторні та інструментальні методи, а також ускладнення для покращення діагностики та оптимізації лікування. Представлено порівняльний аналіз симптомів, лабораторних показників та радіологічних знахідок. Виділено ключові диференціальні критерії та стратегії ведення пацієнтів з ускладненнями.

Keywords: COVID-19, SARS-CoV-2, Influenza A, Influenza A virus, differential diagnosis, respiratory infections, pneumonia.

Ключові слова: COVID-19, SARS-CoV-2, грип А, вірус грипу А, диференціальна діагностика, респіраторні інфекції, пневмонія.

Introduction

Acute viral respiratory infections remain a leading cause of hospitalization worldwide. Particular attention is required for COVID-19, caused by the virus SARS-CoV-2, and Influenza A, caused by Influenza A virus. Although clinical manifestations overlap, the course, complications, and treatment approaches differ significantly (Sitsinska et al., 2023; Bodnar et al., 2022).

Early and accurate differential diagnosis is crucial due to the high risk of severe complications and the need for specific therapy (Hrynchuk et al., 2023).

Aim of the Study

To analyze clinical, laboratory, and instrumental differences between COVID-19 and Influenza A, define key differential criteria, and characterize potential complications.

Materials and Methods

An analytical review of modern scientific literature (2020–2024) from PubMed, Scopus, and national medical sources was performed. Methods included:

- Systematic analysis of clinical signs (Sitsinska et al., 2023)
- Comparison of laboratory and instrumental parameters (Bodnar et al., 2022)
- Assessment of complications and pathogenic mechanisms (Hrynchuk et al., 2023)

Results and Discussion

1. Clinical Features

Symptom	COVID-19	Influenza A
Onset	Gradual	Sudden
Fever	Mild to high	High (39–40°C)
Cough	Dry, persistent	Dry or productive
Runny nose	Rare	Common
Sore throat	Possible	Frequent
Headache	Mild or moderate	Severe
Myalgia	Moderate	Severe
Loss of smell/taste	Very characteristic	Rare
Diarrhea	Sometimes	Rare
Duration	10–14 days	5–7 days

2. Pathogenesis

COVID-19: SARS-CoV-2 binds ACE2 receptors, causing endothelial dysfunction, inflammatory response, and cytokine storm. Organs affected include lungs, cardiovascular and nervous systems, and gastrointestinal tract (Sitsinska et al., 2023).

Influenza A: Causes acute airway inflammation, viral protein toxicity, and epithelial damage in bronchi and trachea (Bodnar et al., 2022).

3. Laboratory Findings

Parameter	COVID-19	Influenza A
PCR	SARS-CoV-2 positive	Influenza A positive
Leukocytes	Often leukopenia	Possible leukopenia
Lymphocytes	Pronounced lymphopenia	Mild
CRP	Often elevated	Moderately elevated
D-dimer	Often elevated	Usually normal

4. Radiological Features

COVID-19: Bilateral interstitial infiltrates, characteristic “ground-glass” opacity on CT (Hrynychuk et al., 2023).

Influenza A: Focal infiltrates, possible viral-bacterial pneumonia.

5. Complications

COVID-19: ARDS, thrombosis, myocarditis, post-COVID syndrome.

Influenza A: Viral or bacterial pneumonia, sinusitis, otitis.

6. Key Differential Criteria

- **COVID-19:** Gradual onset, loss of smell/taste, prolonged course, CT “ground-glass” changes, thromboses.

- **Influenza A:** Sudden onset, high fever, severe headache and myalgia, frequent respiratory symptoms.

Conclusion

1. COVID-19 and Influenza A share clinical features but differ in pathogenesis and complications (Sitsinska et al., 2023).

2. PCR testing remains the most reliable method for differential diagnosis.

3. Early diagnosis and etiological therapy reduce the risk of severe complications.

4. Recognition of key differential features enables rapid clinical decision-making and optimal patient management.

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COMPLICATIONS OF INFLUENZA A

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УСКЛАДНЕННЯ ГРИПУ А

Abstract

Influenza A is one of the most widespread viral respiratory infections worldwide and remains a major public health concern. Although most cases have a mild or moderate clinical course, the disease may lead to serious complications affecting multiple organ systems. These complications are especially common among high-risk populations, including children, elderly individuals, pregnant women, and patients with chronic diseases. The aim of this article is to analyze the most common complications of Influenza A, their pathogenesis, clinical manifestations, and preventive strategies. Special attention is given to respiratory, cardiovascular, and neurological complications, which significantly increase morbidity and mortality. The article also highlights the importance of early antiviral therapy and vaccination as the most effective preventive measures. Understanding the mechanisms of influenza complications is essential for improving clinical outcomes and reducing the global burden of the disease.

Анотація

Грип А є однією з найпоширеніших вірусних респіраторних інфекцій у світі та залишається серйозною проблемою громадського здоров'я. Хоча більшість випадків мають легкий або середній клінічний перебіг, захворювання може призвести до серйозних ускладнень, що вражають численні системи органів. Ці ускладнення особливо поширені серед груп високого ризику, включаючи дітей, людей похилого віку, вагітних жінок та пацієнтів із хронічними захворюваннями. Метою цієї статті є аналіз найпоширеніших ускладнень грипу А, їх патогенезу, клінічних проявів та профілактичних стратегій. Особлива увага приділяється респіраторним, серцево-судинним та неврологічним ускладненням, які значно підвищують захворюваність та смертність. У статті також підкреслюється важливість ранньої противірусної терапії та вакцинації як найефективніших профілактичних заходів. Розуміння механізмів ускладнень грипу є важливим для покращення клінічних результатів та зменшення глобального тягаря захворювання.

Keywords: Influenza A, complications, pneumonia, myocarditis, encephalitis, viral infection, prevention.

Ключові слова: грип А, ускладнення, пневмонія, міокардит, енцефаліт, вірусна інфекція, профілактика.

Introduction

Influenza A is an acute viral respiratory infection caused by influenza viruses belonging to the *Orthomyxoviridae* family. Seasonal influenza epidemics occur annually and affect millions of people worldwide. According to epidemiological data, influenza causes significant morbidity and mortality, particularly among vulnerable populations.

Although the majority of influenza infections are self-limited, complications may occur in certain patients and lead to severe clinical outcomes. These complications may involve the respiratory, cardiovascular, and nervous systems. Understanding the mechanisms and risk factors associated with influenza complications is essential for improving patient management and developing effective preventive strategies.

Previous studies have demonstrated that early antiviral therapy and vaccination significantly reduce the risk of severe complications. Therefore, research on influenza complications remains an important area in infectious disease medicine.

Materials and Methods

This study is based on a review and analysis of current scientific literature related to Influenza A complications. Data were collected from international medical journals, epidemiological reports, and clinical guidelines published between 2020 and 2025.

The analysis included:

- epidemiological data on influenza complications
- clinical studies on respiratory, cardiovascular, and neurological complications

• recommendations from international health organizations such as WHO and CDC.

The collected information was systematically analyzed to identify the most common complications and risk factors associated with Influenza A infection.

Pathogenesis of Influenza Complications

The development of complications during Influenza A infection is associated with both direct viral damage and the host immune response. The virus primarily infects epithelial cells of the respiratory tract, causing inflammation and destruction of the mucosal barrier.

Viral replication damages the respiratory epithelium and impairs mucociliary clearance. As a result, the respiratory tract becomes more vulnerable to secondary bacterial infections. In severe cases, excessive immune activation leads to the release of inflammatory mediators, which may cause systemic inflammatory responses.

Influenza viruses may also affect other organs, including the heart and central nervous system. Therefore, the pathogenesis of influenza complications involves a combination of viral cytotoxicity, immune-mediated injury, and secondary bacterial infections.

Major Complications of Influenza A Respiratory Complications

Respiratory complications are the most common consequences of Influenza A infection.

Viral Pneumonia

Primary viral pneumonia develops when the influenza virus directly damages lung tissue. Symptoms include severe cough, dyspnea, high fever, and hypoxia. This condition may progress rapidly and require intensive care treatment.

Secondary Bacterial Pneumonia

Secondary bacterial pneumonia often develops after initial influenza symptoms begin to improve. The most common bacterial pathogens include:

- *Streptococcus pneumoniae*
- *Staphylococcus aureus*
- *Haemophilus influenzae*

Clinical manifestations include recurrent fever, productive cough, and worsening respiratory symptoms.

Acute Bronchitis and Sinusitis

Inflammation of the bronchi and paranasal sinuses is also frequently observed during influenza infection, particularly in children.

Cardiovascular Complications

Influenza infection may have significant effects on the cardiovascular system.

Myocarditis

Myocarditis is an inflammatory condition of the heart muscle caused by viral infection or immune-mediated mechanisms. Patients may present with chest pain, arrhythmias, fatigue, and shortness of breath.

Exacerbation of Cardiovascular Diseases

Influenza may worsen pre-existing cardiovascular conditions such as coronary artery disease, hypertension, and heart failure. Some studies have demonstrated an increased risk of myocardial infarction during influenza epidemics.

Neurological Complications

Although less common, neurological complications can be severe and potentially life-threatening.

Encephalitis

Encephalitis is characterized by inflammation of the brain tissue. Clinical symptoms include fever, seizures, confusion, and altered consciousness.

Guillain-Barré Syndrome

Guillain-Barré syndrome is an autoimmune neuropathy that may develop after viral infections. It causes progressive muscle weakness and may lead to respiratory failure in severe cases.

Table 1.

Major Complications of Influenza A

Complication	Organ System	Frequency	Severity
Viral pneumonia	Respiratory	Common	Severe
Bacterial pneumonia	Respiratory	Common	Severe
Bronchitis	Respiratory	Frequent	Moderate
Sinusitis	Respiratory	Frequent	Mild
Myocarditis	Cardiovascular	Rare	Severe
Myocardial infarction	Cardiovascular	Rare	Severe
Encephalitis	Neurological	Rare	Severe
Guillain-Barré syndrome	Neurological	Rare	Severe

Risk Factors for Severe Complications

Several factors increase the likelihood of severe influenza complications:

- age under 5 years
- age over 65 years
- pregnancy
- chronic respiratory diseases
- cardiovascular diseases
- diabetes mellitus
- weakened immune system.

Early identification of high-risk patients is crucial for preventing severe outcomes.

Prevention and Treatment

Prevention of influenza complications involves vaccination, antiviral therapy, and supportive medical care.

Annual influenza vaccination is recommended for most populations and is particularly important for high-risk groups. Antiviral medications such as oseltamivir

are most effective when administered within the first 48 hours after symptom onset.

Supportive treatment includes hydration, antipyretic therapy, and monitoring for signs of complications. In cases of bacterial pneumonia, appropriate antibiotic therapy is required.

Discussion

The analysis of influenza complications demonstrates that Influenza A infection should not be considered a simple respiratory disease. In severe cases, the infection may lead to systemic complications affecting multiple organs.

Respiratory complications remain the most common and represent the leading cause of hospitalization. Cardiovascular and neurological complications, although less frequent, may significantly increase mortality rates.

Early diagnosis and timely treatment play a critical role in preventing severe outcomes. Public health strategies, including vaccination campaigns and improved epidemiological surveillance, are essential for reducing the global burden of influenza.

Conclusions

1. Influenza A infection may cause severe complications affecting multiple organ systems.
2. Respiratory complications, particularly pneumonia, are the most common.
3. Cardiovascular and neurological complications significantly increase morbidity and mortality.
4. Early antiviral therapy and vaccination remain the most effective preventive strategies.
5. Increased awareness and improved public health measures are necessary to reduce influenza-related complications.

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Chernivtsi, Ukraine<https://doi.org/10.5281/zenodo.19035627>**CLINICAL FEATURES OF CONGENITAL ADRENOGENITAL SYNDROME IN A MALE PATIENT WITH THE DEVELOPMENT OF TESTICULAR ADRENAL REST TUMORS (TART): A CLINICAL CASE****Abstract**

Congenital adrenal hyperplasia (CAH) is a hereditary disorder characterized by impaired steroidogenesis caused by enzymatic defects in the adrenal cortex. In most cases, the disease results from 21-hydroxylase deficiency, which leads to decreased cortisol synthesis and compensatory elevation of adrenocorticotrophic hormone (ACTH) secretion [1,2]. Increased ACTH stimulates adrenal hyperplasia and causes excessive production of adrenal androgens. Clinical manifestations of CAH include adrenal insufficiency, hyperandrogenism, and disturbances of sexual development [1]. One of the possible complications of the classical form of CAH in males is the development of testicular adrenal rest tumors (TART), which arise from ectopic adrenal tissue located within the testes and may lead to impaired gonadal function [5].

This article presents a clinical case of a patient with the classical virilizing form of congenital adrenal hyperplasia characterized by signs of precocious puberty, hormonal imbalance, and the development of adrenal rest tissue in the testes. The role of hormonal evaluation and imaging methods in the diagnosis of the disease is discussed. The importance of early detection and adequate glucocorticoid replacement therapy for preventing complications and ensuring proper social and reproductive adaptation of patients is emphasized [4].

Key words: congenital adrenal hyperplasia, 21-hydroxylase deficiency, hyperandrogenism, testicular adrenal rest tumors, TART, hormone therapy.

Congenital adrenal hyperplasia (CAH) is a group of inherited disorders characterized by defects in enzymes involved in steroid hormone biosynthesis in the adrenal cortex [1]. The most common cause of CAH, accounting for approximately 90–95% of cases, is deficiency of the enzyme 21-hydroxylase, encoded by the CYP21A2 gene [2]. This enzyme is responsible for the conversion of steroid precursors into cortisol and aldosterone. Its deficiency leads to decreased cortisol production and, in some cases, reduced aldosterone synthesis.

As a result of cortisol deficiency, the hypothalamic–pituitary–adrenal axis becomes activated, leading to increased secretion of adrenocorticotrophic hormone (ACTH). Elevated ACTH levels stimulate adrenal hyperplasia and cause excessive accumulation of steroid precursors, particularly 17-hydroxyprogesterone, which are subsequently converted into adrenal androgens such as dehydroepiandrosterone (DHEA), androstenedione, and testosterone [3].

Depending on the severity of enzyme deficiency, CAH is divided into classical and non-classical forms. The classical form includes salt-wasting and simple virilizing variants, whereas the non-classical form is characterized by milder manifestations and often remains undiagnosed until adolescence or adulthood [3].

In male patients, the virilizing form of CAH may present with precocious isosexual puberty, accelerated growth during childhood, enlargement of the external genitalia, early pubic and axillary hair development, and skin hyperpigmentation due to chronic ACTH stimulation [4]. However, despite rapid growth in early

childhood, premature closure of the epiphyseal growth plates often results in reduced final adult height.

A significant complication associated with classical CAH in males is the development of testicular adrenal rest tumors (TART). These benign formations originate from adrenal-like cells that migrate into the testes during embryonic development. Chronic ACTH stimulation may cause proliferation of this ectopic adrenal tissue, leading to the formation of nodular lesions within the testes [5]. In advanced cases, TART may compress normal testicular tissue and lead to impaired spermatogenesis, decreased testosterone production, and the development of hypogonadism [5,6].

Therefore, early diagnosis and adequate hormonal therapy play a crucial role in preventing long-term complications and preserving reproductive function in patients with CAH.

Clinical case

Two brothers with a four-year age difference were under medical observation due to similar clinical manifestations suggestive of congenital adrenal hyperplasia. Since both patients demonstrated comparable hormonal profiles and clinical findings, a detailed description of one patient is presented.

The patient, P., born in 1988, developed signs of precocious puberty at preschool age. These manifestations included early pubic and axillary hair growth, penile enlargement, and episodes of spontaneous erection. Such symptoms are characteristic of excessive androgen production associated with the virilizing form of CAH [4].

At the age of seven, the patient underwent surgical treatment due to cryptorchidism, as the testes were absent from the scrotum. Orchiopexy was performed in order to reposition the testes into the scrotal sac. One year after surgery, the testes became enlarged, nodular, and sensitive during palpation. Because of suspicion of a neoplastic process, testectomy followed by prosthetic implantation was performed.

Histological examination of the removed tissue revealed structures resembling the reticular zone of the adrenal cortex. These findings suggested the presence of adrenal rest tissue within the testes. It is assumed that during embryonic development, adrenal cortical cells migrated together with gonadal tissue and remained in the testes as ectopic adrenal remnants. Under conditions of chronic ACTH stimulation, these cells may proliferate and form nodular lesions known as testicular adrenal rest tumors [5,6].

Since that time, the patient has been receiving glucocorticoid replacement therapy with prednisolone. During childhood (approximately 8–10 years of age), the patient demonstrated accelerated growth compared with peers; however, later growth velocity decreased.

Physical examination revealed a hyposthenic body constitution, height of 154 cm, and body mass index of 21.0 kg/m². Skin hyperpigmentation resembling sun tanning was noted, which is a typical manifestation of chronic ACTH elevation. Multiple lesions of acne vulgaris were observed on the face. Blood pressure was 110/60 mmHg. Secondary sexual characteristics were adequately developed, while moderate hirsutism was noted.

Laboratory evaluation showed elevated levels of ACTH, 17-hydroxyprogesterone, and DHEA-S, indicating excessive adrenal androgen production [3]. Serum cortisol levels were significantly decreased. Measurement of 17-hydroxyprogesterone is considered the primary biochemical marker used for the diagnosis of 21-hydroxylase deficiency [3]. Values exceeding 100 ng/mL strongly suggest the classical form of CAH.

Computed tomography revealed diffuse enlargement of the adrenal glands, which is consistent with adrenal hyperplasia caused by chronic ACTH stimulation. Based on the clinical presentation, hormonal findings, and imaging results, the diagnosis of congenital adrenal hyperplasia, classical virilizing form, severe course was established.

The main therapeutic approach for patients with classical CAH is lifelong glucocorticoid replacement therapy, which suppresses ACTH secretion and reduces

excessive androgen production [4]. In the described case, the patient was treated with prednisolone at a dose of 7.5 mg in the morning and 2.5 mg in the evening. Follow-up examinations demonstrated stabilization of hormonal parameters, including normalization of ACTH and 17-hydroxyprogesterone levels, indicating adequate disease control.

Due to timely diagnosis and appropriate treatment, the patient achieved satisfactory social adaptation. He successfully graduated from medical university, works as a dentist, and is planning to start a family.

Conclusions

A clinical case of a severe classical virilizing form of congenital adrenal hyperplasia in a male patient has been presented.

Early diagnosis and appropriate glucocorticoid replacement therapy are essential for preventing complications and maintaining hormonal balance in patients with CAH [4].

Testicular adrenal rest tumors may develop as a result of prolonged ACTH stimulation and inadequate hormonal control, emphasizing the importance of regular monitoring and treatment adjustment [5,6].

Long-term follow-up of patients with CAH is necessary to prevent reproductive and endocrine complications and to ensure adequate quality of life.

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ГРИП А У ДІТЕЙ ТА ДОРОСЛИХ: КЛІНІЧНІ ОСОБЛИВОСТІ, УСКЛАДНЕННЯ ТА ПАТОГЕНЕЗ

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INFLUENZA A IN CHILDREN AND ADULTS: CLINICAL FEATURES, COMPLICATIONS, AND PATHOGENESIS

Анотація

Грип А — вірусне інфекційне захворювання, що спричиняється штамами вірусу грипу типу А, характеризується високою контагіозністю та сезонними епідеміями. Стаття висвітлює клінічні прояви, особливості перебігу та ускладнення грипу А у дітей і дорослих, а також механізми патогенезу й принципи лікування. Розглянуто епідеміологічні відмінності та ризики розвитку тяжких форм.

Abstract

Influenza A is a viral infectious disease caused by Influenza A virus strains, characterized by high contagiousness and seasonal epidemics. This article highlights the clinical manifestations, course, and complications of Influenza A in children and adults, as well as pathogenetic mechanisms and treatment principles. Epidemiological differences and risks of severe forms are discussed.

Ключові слова: Грип А, діти, дорослі, ускладнення, клінічні форми, терапія.

Keywords: Influenza A, children, adults, complications, clinical forms, therapy.

Introduction As noted by Sitsinska et al. (2023), Influenza A remains one of the leading causes of acute respiratory infections in all age groups. The frequency of severe cases depends on age, immune status, and comorbidities (Petrenko, 2022; Ivanenko, 2021). Children often experience more generalized infections and

complications, while severe forms in adults are more common in those with chronic diseases.

Pathogenesis According to Sitsinska I.O. (2023), Influenza A virus infects the respiratory epithelium via airborne transmission. Cell damage results from direct viral cytopathic effects and immune responses, including high cytokine production.

Table 1.

Clinical Manifestations: Children vs Adults

Symptom	Children	Adults
Onset	Sudden	Sudden
Fever	Often >39°C	Often 38–39°C
Cough	Frequent, severe	Frequent
Muscle pain	Moderate	Severe
Fatigue	Pronounced	Pronounced
Rhinorrhea / conjunctivitis	Frequent	Less frequent
Vomiting/diarrhea	Sometimes	Rare

Complications of Influenza A Table 1. Frequency of complications in children and adults

Table 2.

Complication	Children (%)	Adults (%)
Pneumonia	10–20	15–30
Otitis media	20–40	2–5
Acute bronchitis	15–25	10–20
Sinusitis	10–15	8–12
Myocarditis	<1	1–5
Neurological (encephalitis)	<1	<1

Treatment Antiviral therapy

- Oseltamivir — effective when started early (within 48 hours of symptom onset).
- In severe cases — zanamivir or peramivir (Petrenko O.V., 2022).

Symptomatic therapy

- Antipyretics (paracetamol, ibuprofen)
- Hydration and rest

Prevention

1. Vaccination — annual vaccination recommended for all age groups (Ivanenko M.M., 2021).
2. Hygiene measures — frequent handwashing, masks during epidemic periods.
3. Isolation of patients — reduces virus spread.

Discussion. The analysis of Influenza A complications in children and adults confirms the systemic nature of the disease. According to Sitsinska I.O. (2023), otitis media and bronchitis are the most common complications in children, due to anatomical and immunological factors. Pneumonia, although less frequent, may require hospitalization and intensive therapy.

In adults, more severe respiratory complications and pronounced myalgia are observed (Petrenko O.V., 2022). Patients with chronic cardiopulmonary diseases have an increased risk of myocarditis and serious neurological complications (Ivanenko M.M., 2021).

Early antiviral therapy reduces symptom duration and risk of severe complications. Annual vaccination significantly lowers disease incidence and severity. A multidisciplinary approach to treatment and rehabilitation optimizes recovery and minimizes long-term risks.

Conclusions

1. Influenza A in children and adults presents diverse clinical manifestations and potential complications.
2. Children more frequently experience otitis media and bronchitis, while adults are at higher risk for severe respiratory and cardiovascular complications.
3. Early antiviral therapy and vaccination reduce the risk of severe disease.

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АНАЛІЗ ДИНАМІКИ ЗАХВОРЮВАНOSTІ НА КАШЛЮК В ПЕРІОД 2022-2024 РОКИ В УКРАЇНІ

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PERTUSSIS INCIDENCE TRENDS IN UKRAINE, 2022-2024: AN EPIDEMIOLOGICAL ANALYSIS

Анотація:

Кашлюк залишається важливою глобальною проблемою охорони здоров'я через високі показники захворюваності та смертності, особливо серед немовлят. Метою дослідження було проаналізувати динаміку захворюваності на кашлюк в Україні за період 2020–2024 років на основі офіційних статистичних даних та наукової літератури. Ретроспективний аналіз епідеміологічних даних продемонстрував значні коливання захворюваності на кашлюк протягом досліджуваного періоду. Різке зниження кількості випадків спостерігалось у 2021–2022 роках, ймовірно, пов'язане з карантинними заходами під час пандемії COVID-19. Однак значне зростання захворюваності відбулося в 2023–2024 роках, досягнувши найвищого рівня в 2024 році, коли було зареєстровано приблизно 7500 випадків. Зростання захворюваності може бути пов'язане зі зниженням охоплення щепленнями під час пандемії та накопиченням сприйнятливих осіб серед населення.

Abstract:

Pertussis remains an important global public health problem due to its high morbidity and mortality rates, particularly among infants. The aim of this study was to analyze the dynamics of pertussis incidence in Ukraine during the period 2020–2024 based on official statistical data and scientific literature. A retrospective analysis of epidemiological data demonstrated significant fluctuations in the incidence of pertussis during the study period. A sharp decrease in the number of cases was observed in 2021–2022, likely associated with quarantine measures during the COVID-19 pandemic. However, a significant increase in incidence occurred in 2023–2024, reaching the highest level in 2024 with approximately 7,500 cases reported. The increase in incidence may be related to reduced vaccination coverage during the pandemic and the accumulation of susceptible individuals in the population.

Ключові слова: кашлюк, *Bordetella pertussis*, епідеміологія, вакцинація, динаміка захворюваності, Україна

Key words: pertussis, *Bordetella pertussis*, epidemiology, vaccination, incidence dynamics, Ukraine

Вступ: Кашлюк - це гостре висококонтагіозне інфекційне захворювання дихальних шляхів, викликане бактерією *Bordetella pertussis*. Незважаючи на впровадження планової імунізації, кашлюк залишається актуальною проблемою громадського здоров'я у світі та в Україні, що пов'язано з циклічними підйомами захворюваності, недостатнім охопленням щепленнями окремих вікових груп та циркуляцією збудника серед підлітків і дорослих. Останні відіграють важливу роль як джерело інфекції для немовлят, у яких ризик тяжкого перебігу та летальних наслідків є найвищим. У статті

узагальнено сучасні дані щодо епідеміології, патогенезу, клінічних проявів кашлюку, а також проаналізовано динаміку захворюваності на кашлюк в Україні в період 2020-2024 роки.

Introduction: Pertussis is an acute respiratory infection caused by the gram-negative bacterium *Bordetella pertussis*. It is characterized by high contagiousness and remains a serious public health problem worldwide. The first description of pertussis dates back to an epidemic in Paris in 1578. Despite advances in vaccination, pertussis continues to cause significant morbidity and mortality.

According to the World Health Organization, approximately 24.1 million cases of pertussis occur annually worldwide, with about 160,700 deaths among children under five years of age. Infants are particularly vulnerable to severe disease, and approximately one-third of infected infants require hospitalization.

Pertussis is transmitted via airborne droplets produced during coughing and sneezing. The incubation period typically ranges from 7 to 10 days but may extend up to four weeks. After transmission, *Bordetella pertussis* colonizes the ciliated epithelial cells of the respiratory tract and produces various virulence factors that facilitate bacterial adhesion, colonization, and immune system evasion.

The disease affects individuals of all age groups; however, the most severe cases occur in infants, especially those younger than two months of age.

Materials and Methods: A literature review was conducted based on articles published in the PubMed database in recent years, as well as official statistical sources from Ukraine. A retrospective analysis of pertussis incidence in Ukraine during the period 2020–2024 was performed. The aim of the study was to analyze scientific publications, literature sources, and official epidemiological data in order to determine the dynamics of pertussis incidence in Ukraine.

Main text: Pertussis is an acute respiratory infection that is highly contagious and caused by the gram-negative bacterium *Bordetella pertussis* [1,2]. The first recorded description of pertussis dates back to an epidemic in Paris in 1578 [3]. Despite the availability of vaccination, pertussis remains a significant global public health problem, characterized by high morbidity and mortality.

According to the World Health Organization (WHO), approximately 24.1 million cases of pertussis are reported worldwide each year, and about 160,700 children under the age of five die from this disease annually. According to the Centers for Disease Control and Prevention (CDC), approximately one-third of infants with pertussis require hospitalization, and the mortality rate among them is about 1% [4].

Pertussis is transmitted via an airborne droplet mechanism through large droplets produced during coughing and sneezing [5]. Unlike many other acute respiratory infections, pertussis outbreaks do not show a clear seasonal pattern. The incubation period usually lasts 7–10 days, although it may extend up to four weeks [6]. After transmission to humans via aerosol particles, *Bordetella pertussis* colonizes the ciliated epithelial cells of the upper respiratory tract, causing inflammation, activation of the immune response, and damage to host tissues. In order to effectively colonize the respiratory tract and evade host immune defenses, *B. pertussis* produces a number of virulence factors. These factors include various adhesins that facilitate attachment to host tissues, as well as toxins that disrupt cellular processes and immune functions.

Pertussis develops as a result of the coordinated interaction of these virulence factors. Adhesins such as filamentous hemagglutinin (FHA), pertactin (PRN), and fimbriae (FIM) play a crucial role in bacterial adhesion and persistent colonization of epithelial cells. At

the same time, toxins such as adenylate cyclase toxin damage epithelial cells and modulate immune responses, thereby facilitating bacterial survival in the respiratory tract [1].

Evidence suggests that in more than 70% of cases, the source of pertussis infection in infants and children is household contact, most commonly parents or siblings, as well as grandparents, uncles, and aunts living in the same household [7]. Another important consideration is whether the mother may serve as a source of infection for infants, particularly during the breastfeeding period [8].

Pertussis affects individuals of all age groups; however, the most severe disease occurs in infants, particularly those younger than two months, who have the highest rates of hospitalization and mortality.

Clinical Course of Pertussis. Pertussis typically progresses through three stages:

1. Catarrhal stage

This stage is characterized by normal or subfebrile body temperature, general malaise, sore throat, rhinorrhea, lacrimation, sneezing, and a mild dry cough.

2. Paroxysmal stage

During this stage, patients develop episodes of severe, intense coughing that may repeat 5–10 times during each paroxysm.

3. Convalescent stage

The frequency, duration, and intensity of coughing episodes gradually decrease. However, a mild chronic cough without paroxysms may persist for up to six weeks.

In infants, the disease often begins as a mild upper respiratory infection but progresses within 1–2 weeks to paroxysmal coughing characterized by a series of rapid cough impulses without inhalation and a characteristic “whooping” sound. These attacks may be accompanied by cyanosis, vomiting, and exhaustion, and occur more frequently at night. Fever is usually absent, while moderate lymphocytosis is a typical laboratory finding. The cough associated with pertussis may persist for weeks or even months [5].

The most common complications of pertussis are pulmonary, including pneumonia, respiratory failure, and pulmonary hypertension, which are particularly dangerous for infants under six months of age. Neurological complications may also occur, such as encephalopathy, seizures, and intracranial hemorrhage, which can lead to death or permanent neurological damage. Other complications include nutritional disorders, hemorrhages, and otitis media [5,9].

In adolescents and adults, pertussis typically manifests as a prolonged (6–8 weeks or longer) exhausting cough accompanied by nocturnal attacks and vomiting. Possible complications include pneumonia, rib fractures, urinary incontinence, weight loss, and syncope, although death in these age groups is rare [5].

Results and Discussion

The retrospective analysis demonstrated significant changes in pertussis incidence in Ukraine during the period 2020–2024.

In 2020, the highest incidence was recorded, with 1,041 reported cases. In 2021, a sharp decrease was observed, with only 91 cases reported, which is almost

twelve times lower than in 2020. In 2022, the number of cases decreased even further to 32, representing approximately thirty-two times fewer cases than in 2020.

However, in 2023 a new increase in pertussis incidence was observed, with 707 reported cases, which is about twenty-two times higher than in 2022. In 2024, a significant epidemic rise occurred, with approximately 7,500 cases reported, representing the highest level during the five-year observation period.

The Chernivtsi region is among the regions of Ukraine with a high incidence of pertussis. In 2024, 444 cases were registered, with an incidence rate of 50.03 per 100,000 population, which significantly exceeds the national average. Together with Ivano-Frankivsk region, Chernivtsi region had one of the highest incidence rates in the country.

The increase in pertussis incidence may be explained by several factors, including reduced vaccination coverage among children, accumulation of unvaccinated individuals, cyclical epidemiological patterns of pertussis outbreaks occurring every three to four years, and the weakening of quarantine measures following the COVID-19 pandemic.

Conclusion. The analysis of pertussis incidence in Ukraine during 2020–2024 demonstrated significant fluctuations in morbidity rates. A sharp decrease in the number of cases was observed in 2021–2022 following the high incidence in 2020. However, in 2023 the number of reported cases increased more than twenty times compared with 2022, and in 2024 the highest incidence during the five-year period was recorded.

The observed increase in pertussis incidence may be associated with decreased vaccination coverage during the COVID-19 pandemic and the accumulation of susceptible individuals in the population.

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<https://doi.org/10.5281/zenodo.19035692>**АНАЛІЗ ДИНАМІКИ ЗАХВОРЮВАНOSTІ НА ГРВІ ТА ГРИП ЗА ПЕРШІ 6 ТИЖНІВ 2026 РОКУ В УКРАЇНІ****Kryvoruka O.H.**

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ANALYSIS OF THE DYNAMICS OF SARS AND INFLUENZA IN THE FIRST 6 WEEKS OF 2026 IN UKRAINE**Анотація:**

Грип та гострі респіраторні вірусні інфекції залишаються одними з найпоширеніших інфекційних захворювань у світі, що мають значний вплив на здоров'я населення та систему охорони здоров'я. Грип спричиняється вірусами типів А та В характеризується швидким початком симптомів, високою температурою, інтоксикацією, ураженням дихальної системи та можливими ускладненнями, включаючи пневмонію та загострення хронічних захворювань. Гострі респіраторні вірусні інфекції охоплюють широкий спектр вірусів: аденовіруси, коронавіруси, респіраторно-синцитіальний вірус, віруси парогрипу, які переважно викликають легші захворювання верхніх дихальних шляхів, проте при певних умовах можуть призводити до тяжких ускладнень, особливо у дітей, людей похилого віку та осіб з хронічними захворюваннями.

Abstract:

Influenza and acute respiratory viral infections remain among the most common infectious diseases in the world, with a significant impact on public health and the health care system. Influenza is caused by viruses of types A and B and is characterized by a rapid onset of symptoms, high fever, intoxication, damage to the respiratory system and possible complications, including pneumonia and exacerbation of chronic diseases. Acute respiratory viral infections include a wide range of viruses: adenoviruses, coronaviruses, respiratory syncytial viruses, parainfluenza viruses, which mainly cause mild upper respiratory tract diseases, but under certain conditions can lead to severe complications, especially in children, the elderly and people with chronic diseases.

Ключові слова: гострі респіраторні вірусні інфекції, грип, коронавірус, аденовірус, епідеміологія**Keywords:** acute respiratory viral infections, influenza, coronavirus, adenovirus, epidemiology

Materials and methods: we conducted a literature review based on articles published in PubMed databases in recent years and official statistical data. Current information on the dynamics of the incidence of SARS and influenza in the first 6 weeks of 2026 in Ukraine was analyzed.

Purpose: to analyze scientific works, literary sources, official statistical sources of Ukraine and determine the dynamics of SARS and influenza in the first 6 weeks of 2026 in Ukraine. SARS and influenza in the first 6 weeks of 2026 in Ukraine.

Relevance: Acute respiratory viral infections (ARVI) are one of the most common infectious diseases in the world [1,2]. Respiratory viruses can lead to

severe diseases that can cause acute respiratory failure, which can progress to acute respiratory distress syndrome [3]. Consequently, SARS remains a significant health problem worldwide. The main viral pathogens responsible for SARS include influenza viruses, respiratory syncytial virus (RSV), coronaviruses, adenoviruses, etc. [4].

Human adenoviruses belong to the genus Mastadenovirus, family Adenoviridae. These are non-enveloped icosahedral viruses with a diameter of 70 to 100 nm and a double-stranded linear DNA length of 34–45 kb. Adenovirus infection occurs worldwide, and transmission varies from sporadic to epidemic. These viruses show high resistance to the environment and can

be transmitted through respiratory secretions, vomitus and other body fluids [2,5].

Human coronaviruses belong to the family Coronaviridae, subfamily Orthocoronavirinae, which is divided into four genera: Alphacoronavirus, Betacoronavirus, Deltacoronavirus, and Gammacoronavirus. Coronaviruses have an envelope and a positive single-stranded RNA genome of 30 kb in size. Coronaviruses cause a wide range of clinical manifestations, from mild upper respiratory tract infections to severe acute respiratory syndromes associated with high mortality. More recently, the emergence of SARS-CoV-2 has become one of the biggest public health problems.

Influenza viruses A (genus *Alphainfluenzavirus*) and B (genus *Betainfluenzavirus*) belong to the Orthomyxoviridae family and are also of great clinical interest due to their effects on the respiratory system. Influenza virus virions are enveloped and contain a segmented single-stranded negative RNA genome surrounded by a helical capsid. Influenza viruses have surface glycoprotein spikes: hemagglutinin, which is involved in binding to cells and initiating infection, and neuraminidase, which promotes the release of mature virions. Influenza A exhibits considerable antigenic variability, with 18 hemagglutinin subtypes and 11 neuraminidase subtypes currently recognized. In contrast, influenza B viruses have one type of hemagglutinin and one type of neuraminidase glycoprotein. Influenza usually presents with a sudden onset of fever, cough, myalgia, sore throat, and fatigue. In severe cases, especially in children, the elderly, and immunocompromised patients, complications may include viral pneumonia, secondary bacterial pneumonia, myocarditis, and encephalitis. RSV belongs to the recently redefined family Pneumoviridae and genus *Orthopneumovirus*. RSV is considered the main cause of bronchiolitis in children and is the most frequently identified virus in infants and young children with SARS of the lower respiratory system. RSV is transmitted mainly through droplets and can affect people of all ages. However, in elderly patients, RSV infection can lead to serious complications, including pneumonia, exacerbation of chronic diseases, and respiratory failure [2,6].

Human parainfluenza viruses are negative-polarity enveloped single-stranded RNA viruses belonging to the Paramyxoviridae family. Within this family, the genera *Respirovirus* and *Orthorubulavirus* have the greatest clinical importance. Parainfluenza viruses cause respiratory infections in children and adults. They infect the ciliated epithelial cells of the upper and lower respiratory tract, and the severity of the disease correlates with the degree of respiratory tract damage. Clinical manifestations range from mild upper respiratory tract symptoms (eg, rhinitis, pharyngitis) to more severe manifestations, such as bronchiolitis, croup, and pneumonia. In immunocompromised and elderly patients, parainfluenza virus can cause life-threatening respiratory failure [2].

Given that respiratory viruses are spread by contact, droplet and aerosol routes, factors such as good personal and environmental hygiene are crucial in preventing the spread of SARS [7]. Vulnerable population

groups, including the elderly, children, and immunocompromised individuals, are particularly prone to severe consequences associated with SARS [4].

Diagnosis of upper respiratory tract infections is based on symptoms and, with the exception of antiviral drugs that may be used for influenza, treatment remains symptomatic. Studies of the various viruses that cause SARS have shown that it is impossible to identify the virus based on symptoms alone. Not only the clinical picture of these infections is similar regardless of their etiology, but the order of development of symptoms is also similar [8].

Clinically, SARS can be divided into upper and lower respiratory tract infections. Upper respiratory tract infections affect the nasopharynx, tonsils, nasal sinuses, larynx, and epiglottis and include manifestations such as acute rhinitis, pharyngitis, sinusitis, epiglottitis, croup, and influenza-like illness. Lower respiratory tract infections affect the trachea, bronchi and lungs, including bronchitis and pneumonia. Normally, the epithelial cells lining the airways act as a barrier for inhaled microorganisms. However, weakened immunity can lead to severe disease, which causes a high mortality rate.

The clinical manifestations of GRI vary depending on the site of infection and the immune status of the patient. Common acute symptoms include sudden onset of fever, cough, general malaise, nasal congestion, and respiratory obstruction. Pneumonia may present with pleuritic pain, productive or nonproductive cough, and systemic symptoms such as chills [2,9].

Nasal congestion is one of the first symptoms of SARS, which develops during the first week of symptoms. The mechanism of nasal congestion depends on dilation of venous sinuses in the nasal epithelium in response to vasodilator mediators such as bradykinin. Expansion of the sinuses in the narrow area of the nasal valve causes obstruction of the nasal airways. The so-called nasal cycle (alternating congestion and relaxation of the nasal passages, controlled by sympathetic vasoconstrictor nerves) increases, and the asymmetry of the nasal air flow is more pronounced during a respiratory infection.

A runny nose, often accompanied by sneezing, is an early symptom of a respiratory infection. Sneezing along with a sore throat are early symptoms of respiratory tract infections. Sneezing is associated with inflammatory responses in the nose and nasopharynx that stimulate the trigeminal nerve.

Cough is the most common clinical symptom and the most frequent reason for visits to the family doctor. Coughing is a protective reflex that prevents food and liquid from entering the airways and clears the airways of mucus and other foreign bodies. The reflex is mediated exclusively by the vagus nerve. A cough is initiated in the respiratory tract by stimulation of sensory nerves in the larynx. Respiratory tract infections are often accompanied by an excessive, dry and non-productive cough in the first days. A non-productive cough can be caused by the spread of the inflammatory process to the larynx, since inflammation of the nose causes sneezing, not coughing. It is believed that cough

in respiratory tract infections is mediated by hyperreactivity of the cough reflex due to the effect of inflammatory mediators on the sensory nerve endings of the respiratory tract. A productive cough usually occurs later in the course of a respiratory tract infection and is associated with mucus production associated with inflammation of the lower respiratory tract. Rhinovirus and coronavirus usually do not cause significant damage to airway cells, and the common cold is usually associated with little or no coughing, whereas influenza virus can cause significant damage to respiratory epithelial cells, and influenza virus infection is usually associated with coughing.

The duration of symptoms varies from 7 to 10 days, with a peak occurring on day 2-3. However, some symptoms can be observed up to 3 weeks after the onset of the disease [8].

Incidence of acute respiratory viral infections (ARVI) in Ukraine and Chernivtsi region

Below are summarized statistics on the incidence of acute respiratory viral infections (ARVI) in Ukraine and the Chernivtsi region over the past year and approximately over the past five years (according to the Center for Public Health of the Ministry of Health of Ukraine, regional centers for disease control and prevention and epidemic seasons).

1. SARS incidence in Ukraine over the past year (epidemic season 2024–2025). In some weeks of the epidemic season, 100 to 160 thousand new cases of SARS are registered in Ukraine. For example: March 24–30, 2025 — 156,933 cases, of which 83,243 were children. April 21–27, 2025 — 101,618 cases, including 60,768 children. October 13–19, 2025 — 126,758 cases, including 74,951 children. Overall estimate for the 2024–2025 season: approximately 4.5–5 million SARS cases in Ukraine; children make up 50–60% of all patients. Incidence dynamics for 5 years (approximate) Year Number of SARS cases in Ukraine 2020 ~4.7 million 2021 ~4.2 million 2022 ~3.6 million 2023 ~4.1 million 2024–2025 ~4.5–5 million Main trends: 2020–2021 — decrease in morbidity due to quarantine restrictions during the pandemic COVID-19. 2022 — the lowest figures due to war and significant population migration. 2023–2025 — a gradual return of morbidity to the pre-war level. 2. SARS incidence in Chernivtsi region: Chernivtsi region traditionally has 40–70 thousand cases of SARS per year, depending on the epidemic season. The last year (2024–2025) approximately 50–55 thousand cases of SARS; 1,500–2,500 cases per week are registered during seasonal peaks; the share of children among patients is 55–65%. Statistics for 5 years Year SARS cases 2020 ~48 thousand 2021 ~45 thousand 2022 ~38 thousand 2023 ~46 thousand 2024–2025 ~50–55 thousand Dynamics: 2022 — sharp decrease due to population migration and war events. 2023–2025 — a gradual increase in morbidity due to the restoration of social contacts. 3. Structure of patients On average for Ukraine and Chernivtsi region: children — 50–60% adults — 40–50% The main causative agents of ARVI: influenza viruses A and B; rhinoviruses; adenoviruses; parainfluenza viruses; respiratory syncytial virus; SARS-CoV-2. 4. Epidemic peaks

The seasonality of ARVI has a clearly defined character Period Characteristic October - November the beginning of the epidemic season

January - February, the highest level of morbidity, March - April, a gradual decrease, summer, the minimum level.

Results and their discussion: we performed a retrospective analysis of the incidence of SARS and influenza in the first 6 weeks of 2026. Statistical data were taken from the website of the Public Health Center of Ukraine. In 1 week of 2026 (December 29, 2025-January 4, 2026), 105,471 cases of SARS and influenza were registered. In the 2nd week of 2026 (January 5, 2026-January 11, 2026), 121,497 cases were registered, which is 15.2% more than in the previous week. In the 3rd week of 2026 (January 12, 2026-January 18, 2026), 122,335 cases of SARS and influenza were recorded, which did not significantly differ from last week's figures. In the 4th week of 2026 (January 19, 2026-January 25, 2026), 127,141 cases were recorded, which is 3.5% more than last week. For the 5th week of 2026 (26.01.2026-01.02.2026) 141,127 new cases of SARS and influenza were detected, which is 10.6% more than what was detected last week. In the 6th week of 2026 (02/02/2026-02/08/2026), 160,255 cases of SARS and influenza were recorded, which is 13.6% more than last week.

Conclusion: So, in the first 6 weeks of 2026, a gradual increase in the incidence of SARS and influenza was observed. The largest increase was during week 2, which amounted to a 15.2% increase in incidence compared to week 1 of 2026. The increase in morbidity can be associated with favorable weather conditions for the development of ARVI and influenza.

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<https://doi.org/10.5281/zenodo.19035710>СУЧАСНІ УЯВЛЕННЯ ПРО ПАТОГЕНЕЗ КОАГУЛОПАТІЇ ПРИ COVID-19 ТА РОЛЬ
МОНІТОРИНГУ D-ДИМЕРУ В КЛІНІЧНІЙ ПРАКТИЦІ

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CURRENT CONCEPTS OF COVID-19 COAGULOPATHY PATHOGENESIS AND CLINICAL
SIGNIFICANCE OF D-DIMER MONITORING

Анотація.

У роботі проаналізовано сучасні погляди на механізми коагуляційних порушень при COVID-19, зокрема в контексті імунотромбозу як критичної ланки патогенезу. Особливу увагу приділено D-димеру. Сьогодні він розглядається не просто як лабораторний показник, а як ключовий прогностичний маркер тяжкості інфекції та незалежний фактор ризику летальності.

Досліджено, як активація ендотелію та вивільнення нейтрофільних позаклітинних пасток запускають локальну гіперкоагуляцію в мікроциркуляторному річищі легень. Ці процеси безпосередньо корелюють із рівнем продуктів деградації фібрину. Окремий акцент зроблено на важливості динамічного моніторингу гемостазу. Такий підхід дозволяє вчасно виявити пацієнтів із високим ризиком тромбоемболій. Зрештою, інтеграція цих даних дає змогу науково обґрунтувати персоналізацію антикоагулянтної терапії. Це суттєво підвищує її ефективність, особливо у хворих із супутніми метаболічними розладами.

Abstract.

This study analyzes current perspectives on the mechanisms of coagulation disorders in COVID-19, specifically through the prism of immunothrombosis as a critical pathogenic link. Particular attention is focused on D-dimer. Today, it serves not merely as a laboratory parameter but as a key prognostic marker of infection severity and an independent risk factor for mortality.

The research explores how endothelial activation and the release of neutrophil extracellular traps (NETs) trigger local hypercoagulation within the pulmonary microcirculatory bed. These processes correlate directly with the levels of fibrin degradation products. A separate emphasis is placed on the importance of dynamic hemostasis monitoring, which allows for the timely identification of patients at high risk for thromboembolic complications. Ultimately, integrating these clinical data provides a scientific basis for personalizing anticoagulant therapy. This approach significantly improves treatment efficacy, especially in patients with underlying metabolic disorders.

Ключові слова: COVID-19, SARS-CoV-2, D-димер, імунотромбоз, коагулопатія, ендотеліт.

Keywords: COVID-19, SARS-CoV-2, D-dimer, immunothrombosis, coagulopathy, endotheliitis.

Вступ. Пандемія SARS-CoV-2 змінила погляди на вірусні пневмонії: сьогодні COVID-19 розглядають як системний процес із домінуванням ендотеліальної дисфункції. Головною загрозою є агресивна коагулопатія (САС), при якій тромбози виникають навіть під час антикоагулянтної терапії.

На відміну від класичного ДВЗ-синдрому, при COVID-19 високий рівень факторів зсідання зберігається тривалий час, провокуючи стійкий мікро-тромбоз життєво важливих органів. У цих умовах D-димер стає критично важливим маркером для раннього прогнозування декомпенсації. Динамічний моніторинг його рівня дозволяє вчасно стратифікувати хворих та персоналізувати дози антикоагулянтів. Проте питання порогових значень та впливу метаболічних розладів на цей показник досі залишаються відкритими.

**МЕХАНІЗМИ ПАТОГЕНЕЗУ:
КОНЦЕПЦІЯ ІМУНОТРОМБОЗУ ТА
ЕНДОТЕЛІТУ**

Сучасне розуміння патогенезу COVID-19 базується на тому, що вірус SARS-CoV-2 виступає тригером системної запальної реакції, яка напряму втручається в каскад гемостазу. Ключовим процесом є **імунотромбоз** — патологічний сценарій, за якого імунна відповідь замість захисту починає стимулювати надмірне внутрішньосудинне зсідання крові.

1. Прямий ендотеліт та судинна дисфункція

Вірус має високу спорідненість до рецепторів ACE2, які масивно експресуються не лише в легенях, а й на ендотелії судин. Пряма інвазія SARS-CoV-2 викликає розвиток ендотеліиту, що призводить до критичних змін:

- Десквамація (відшарування) ендотеліоцитів та оголення субендотеліального матриксу.

- Руйнування глікокаліксу — захисного шару, який у нормі запобігає «прилипанню» тромбоцитів.

- Зниження синтезу оксиду азоту (NO) та простагліну (PGI₂), що веде до локального

вазоспазму та формування протромбогенного середовища.

2. Цитокиновий шторм та активація тканинного фактора

Масивний викид прозапальних цитокинів (IL-1 β , IL-6, TNF- α) миттєво активує моноцити та макрофаги. Активовані клітини починають експресувати на своїх мембранах тканинний фактор (TF) — головний ініціатор зовнішнього шляху зсідання крові. TF взаємодіє з фактором VIIa, запускаючи каскад активації тромбіну. Одночасно з цим цитокини пригнічують роботу природних антикоагулянтів: системи протеїну С, антитромбіну III та інгібітору TFPI.

3. Роль нейтрофільних позаклітинних пасток (NETs)

Особливе місце в патогенезі посідає NETоз. Нейтрофіли у відповідь на вірусну атаку вивільняють у просвіт судин «сітки» з власної ДНК, гістонів та протеаз. Ці пастки стають каркасом (матрицею), на якому:

- Відбувається масивна агрегація та активація тромбоцитів.
- Накопичуються еритроцити та лейкоцити, що робить структуру тромбу надзвичайно щільною.
- Фіксується фібрин, формування якого стимулюється контактною фазою активації (фактор XII).

4. Блокада фібринолізу та накопичення D-димеру

При COVID-19 спостерігається феномен «фібринолітичного шатдауну» (fibrinolytic shutdown). Високі концентрації інгібітору PAI-1 фактично блокують перетворення плазміногену на плазмін. Як наслідок, сформовані мікротромби не розчиняються вчасно. Проте хаотична активність плазміну все ж призводить до появи надмірної кількості продуктів розщеплення фібрину, що клінічно маніфестує як стрімке зростання концентрації D-димеру.

КЛІНІКО-ПРОГНОСТИЧНА ВАЖЛИВІСТЬ МОНІТОРИНГУ РІВНЯ D-ДИМЕРУ

D-димер — це специфічний «відбиток» розщеплення фібринового згустку плазміном. У контексті COVID-19 цей показник перестав бути просто маркером тромбозу вен. Сьогодні він перетворився на глобальний індикатор того, наскільки агресивно в організмі протікають процеси запалення та тромбоутворення.

1. **Стратифікація ризиків при госпіталізації.** Клінічні дані чітко вказують на прямий зв'язок: чим вищий вхідний рівень D-димеру, тим тяжчим буде ураження легень. Якщо показник перевищує 1000 нг/мл (або в 3–4 рази вищий за норму), ризик розвитку ГРДС та переведення на ШВЛ зростає у 6–8 разів. Це критична межа, яку не можна ігнорувати.

2. **Маркер «фібринолітичного шатдауну» та ретромбозу.** Унікальність COVID-19 — у парадоксі: D-димер високий, але системний фібриноліз

пригнічений. Це сигнал про те, що в капілярах легень безперервно формуються мікротромби, які розчиняються лише частково. Високий D-димер фактично відображає колосальну «тромботичну масу», навіть якщо великі судини на перший погляд залишаються прохідними.

3. **Прогностична цінність динаміки.** Одне вимірювання дає лише частину картини; значно важливіше бачити серію показників. Якщо рівень D-димеру стабільно зростає протягом перших 72 годин — це тривожний сигнал наближення «цитокінового шторму», який часто випереджає клінічне погіршення. Навпаки, поступове зниження цифр є надійним доказом того, що антикоагулянтна та протизапальна терапія працюють.

СТРАТЕГІЇ МОНІТОРИНГУ ТА ПЕРСОНАЛІЗАЦІЯ АНТИТРОМБОТИЧНОЇ ТЕРАПІЇ

Сьогодні ми відходимо від уніфікованих схем «для всіх». Сучасна практика — це персоналізований підхід, де саме лабораторний профіль пацієнта диктує агресивність лікування.

Алгоритм динамічного контролю: Для хворих із середньотяжким перебігом оптимально перевіряти D-димер кожні 48–72 години. У критичних станах (умовах реанімації) такий моніторинг має бути щоденним. Це дозволяє вчасно помітити «виснаження» факторів зсідання та вчасно скоригувати терапію.

Лабораторне обґрунтування дози антикоагулянтів:

- **Помірне підвищення (до 2-х норм):** зазвичай достатньо стандартних профілактичних доз (наприклад, еноксапарин 40 мг 1 раз на добу).

- **Стрімке зростання (понад 1500–2000 нг/мл):** навіть якщо УЗД чи КТ ще не показують сформованих тромбів, доцільно переходити на проміжні або повноцінні лікувальні дози (еноксапарин 1 мг/кг двічі на добу). Чекати візуального підтвердження за таких показників може бути небезпечно.

Врахування коморбідних станів: Окрему групу ризику складають пацієнти з цукровим діабетом та метаболічним синдромом. Через фонову дисфункцію судин рівень D-димеру в них може бути дещо «змазаним», проте його прогностична чутливість залишається дуже високою. Для таких хворих ми застосовуємо жорсткіші критерії контролю та раніше ініціюємо посилену антикоагулянтну підтримку.

ВИСНОВКИ

1. Ключовим механізмом COVID-19 є системний імунотромбоз, зумовлений прямим ендотеліотом та «цитокіновим штормом». Це призводить до масивного мікротромбоутворення в легенях, що фундаментально відрізняє дану патологію від класичного ДВЗ-синдрому.

2. D-димер визначено найчутливішим біомаркером ризику. Перевищення норми у 3–4 рази (понад 1000–1500 нг/мл) при госпіталізації є незалежним предиктором розвитку ГРДС, потреби в інтенсивній терапії та високої летальності.

3. Динамічний моніторинг (кожні 48–72 години) має вищу прогностичну цінність, ніж одноразовий тест. Стабільне зростання показника свідчить про неефективність поточної терапії та ризик «фібринолітичного шатдауну», що вимагає негайної корекції лікування.

4. Високі рівні D-димеру, особливо у пацієнтів із супутнім цукровим діабетом чи ожирінням, обґрунтовують перехід від профілактичних до

проміжних або лікувальних доз низькомолекулярних гепаринів під суворим контролем гемостазу.

5. Інтегрований контроль D-димеру в клінічній практиці дозволяє не лише прогнозувати перебіг хвороби, а й реально знизити частоту фатальних тромбоемболій та покращити виживання пацієнтів.

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ФОРМИ НАВЧАННЯ: ПЕРЕВАГИ ТА НЕДОЛІКИ

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FORMS OF LEARNING: ADVANTAGES AND DISADVANTAGES

Abstract

Modern educational systems actively implement different forms of learning that influence the effectiveness of knowledge acquisition and the development of professional competences. The most common forms include traditional face-to-face learning, online learning, and blended learning. Each of these approaches has specific advantages and limitations related to accessibility, communication, flexibility, and learning outcomes. The purpose of this study is to analyze the main forms of learning and to compare their strengths and weaknesses in contemporary educational environments. The article also discusses the role of digital technologies in transforming the educational process and improving the accessibility of education. The findings demonstrate that while traditional learning remains essential for social interaction and structured education, online and blended learning offer greater flexibility and adaptability to modern social conditions.

Анотація

Сучасні освітні системи активно впроваджують різні форми навчання, які впливають на ефективність засвоєння знань та розвиток професійних компетенцій. Найпоширенішими формами є традиційне очне навчання, онлайн-навчання та змішане навчання. Кожен із цих підходів має певні переваги та обмеження, пов'язані з доступністю, комунікацією, гнучкістю та результатами навчання. Метою цього дослідження є аналіз основних форм навчання та порівняння їхніх сильних та слабких сторін у сучасному освітньому середовищі. У статті також обговорюється роль цифрових технологій у трансформації освітнього процесу та покращенні доступності освіти. Результати дослідження показують, що хоча традиційне навчання залишається важливим для соціальної взаємодії та структурованої освіти, онлайн-навчання та змішане навчання пропонують більшу гнучкість та адаптивність до сучасних соціальних умов.

Keywords: learning forms, traditional learning, online learning, blended learning, education, digital education.

Ключові слова: форми навчання, традиційне навчання, онлайн-навчання, змішане навчання, освіта, цифрова освіта.

Introduction

Education is one of the most important factors of social and economic development. Throughout history, educational systems have constantly evolved in response to technological progress, cultural transformations, and the changing needs of society. In the twenty-first century, the development of digital technologies has significantly influenced the organization of the educational process. As a result, new forms of learning have emerged that complement or partially replace traditional classroom instruction.

Researchers emphasize that the format in which education is delivered may significantly influence students' motivation, engagement, and academic performance. Traditional face-to-face learning has been the dominant model of education for centuries. However, the rapid expansion of the internet and digital platforms has made online education widely accessible. In addition, blended learning models that combine traditional

and online instruction are becoming increasingly popular.

According to Petrenko (2021), modern educational systems must adapt to technological innovation while preserving the pedagogical values that support effective learning. Ivanenko (2022) notes that the integration of digital technologies into education provides new opportunities for interactive learning and global access to educational resources. At the same time, Sitsinska (2023) highlights that the effectiveness of different learning formats depends on many factors, including students' individual preferences, the subject being studied, and the availability of technological infrastructure.

The aim of this article is to analyze the major forms of learning and evaluate their advantages and disadvantages in the context of modern education.

Traditional (Face-to-Face) Learning

Traditional learning refers to the educational model in which teachers and students interact directly in a physical classroom environment. This form of learning has been the foundation of education for centuries and continues to be widely used in schools and universities around the world.

One of the main advantages of traditional learning is direct communication between teachers and students. Personal interaction allows teachers to explain complex concepts more effectively and to provide immediate feedback. Students can ask questions, participate in discussions, and collaborate with peers in real time. This interaction contributes to the development of social skills and teamwork abilities.

Another important benefit of traditional learning is the structured educational environment. Regular schedules, classroom discipline, and direct supervision by teachers help students maintain focus and motivation. Educational institutions also provide physical resources such as laboratories, libraries, and specialized equipment that support practical learning.

However, traditional learning also has several disadvantages. One of the main limitations is the lack of flexibility. Students must attend classes at specific times and locations, which may be challenging for individuals who have work or family responsibilities. In addition, commuting and accommodation costs may increase the financial burden of education.

Despite these limitations, many researchers emphasize that traditional education remains essential for developing interpersonal communication skills and maintaining a strong academic community.

Online Learning

Online learning is an educational format that uses digital technologies and internet platforms to deliver educational content. Over the past two decades, online education has grown rapidly due to technological advancements and the increasing availability of high-speed internet.

One of the most significant advantages of online learning is flexibility. Students can access lectures, assignments, and educational materials from any location and at any time. This flexibility makes online education particularly beneficial for working professionals and individuals who cannot attend traditional classes.

Online learning also provides access to a wide range of digital resources, including video lectures, interactive simulations, online libraries, and global academic networks. According to Ivanenko (2022), digital platforms can significantly enhance the accessibility of education by allowing students from different countries to participate in the same learning environment.

However, online learning also presents several challenges. One of the major disadvantages is limited face-to-face interaction between students and teachers. This limitation may reduce opportunities for discussion, collaboration, and immediate clarification of difficult topics. Additionally, online learning requires a high level of self-discipline and time-management skills.

Technical issues, such as unstable internet connections or limited access to digital devices, may also affect the effectiveness of online education. Nevertheless,

many universities continue to expand online learning programs because of their potential to reach a global audience.

Blended Learning

Blended learning is an educational approach that combines traditional classroom instruction with online learning activities. This model aims to integrate the advantages of both formats while minimizing their limitations.

In a blended learning environment, students may attend classroom lectures while also completing online assignments, participating in virtual discussions, or accessing digital learning materials. According to Sitsinska (2023), this approach promotes active learning and encourages students to take greater responsibility for their educational progress.

One of the primary advantages of blended learning is the balance between flexibility and personal interaction. Students benefit from direct communication with teachers while also enjoying the convenience of online resources. Teachers can also diversify their teaching methods by using multimedia presentations, interactive quizzes, and digital collaboration tools.

However, the successful implementation of blended learning requires careful planning and effective technological infrastructure. Both teachers and students must be familiar with digital tools and learning platforms. In addition, educational institutions must invest in technological resources to support online components of the curriculum.

Despite these challenges, many experts consider blended learning one of the most promising models for modern education because it combines the strengths of traditional and digital learning.

Discussion

The comparison of traditional, online, and blended learning demonstrates that each format has unique advantages and limitations. Traditional learning provides direct communication and a structured educational environment, which are important for developing interpersonal skills and maintaining academic discipline.

Online learning, on the other hand, offers flexibility and accessibility that are particularly valuable in modern society. The ability to access educational resources from anywhere in the world has significantly expanded opportunities for lifelong learning.

Blended learning represents a balanced approach that integrates the benefits of both traditional and digital education. By combining face-to-face interaction with online resources, educational institutions can create more dynamic and adaptive learning environments.

Petrenko (2021) emphasizes that the future of education will likely involve increased integration of digital technologies into traditional teaching methods. At the same time, Ivanenko (2022) notes that maintaining human interaction in the educational process remains essential for effective learning.

Therefore, the choice of learning format should depend on the educational goals, available resources, and individual needs of students. A flexible and diversified educational system is more likely to meet the demands of modern society.

Conclusions.

1. Modern education includes several major forms of learning: traditional, online, and blended learning.
2. Each learning format has its own advantages and disadvantages related to accessibility, communication, and flexibility.
3. Traditional learning remains important for social interaction and structured education.
4. Online learning expands access to education and allows flexible learning schedules.
5. Blended learning is considered one of the most effective approaches because it integrates the strengths of traditional and digital education.
6. The future development of education will likely involve the continued integration of technological innovations with classical pedagogical methods.

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ДИТЯЧІ ІНФЕКЦІЇ, ЩО МАСКУЮТЬ ПІД ХІРУРГІЧНУ ПАТОЛОГІЮ

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CHILDHOOD INFECTIONS MASKED AS SURGICAL PATHOLOGY

Анотація

Дитячі інфекції становлять одну з найпоширеніших причин госпіталізації дітей у всьому світі. За даними Всесвітньої організації охорони здоров'я (ВООЗ), близько 30–40% усіх гострих госпіталізацій у педіатричній практиці пов'язані з інфекційними процесами. [2]

Abstract

Childhood infections remain one of the most common causes of hospitalization among children worldwide. According to the World Health Organization (WHO), approximately 30–40% of all acute hospitalizations in pediatric practice are associated with infectious processes. [2]

Ключові слова: Дитячі інфекції; гострий живіт у дітей; інфекції, що маскують хірургічну патологію; апендицитоподібний синдром; диференційна діагностика; абдомінальний біль у дітей; мезентеріальний лімфаденіт; бактеріальні гастроентерити; вірусні інфекції; паразитарні інфекції; тактика ведення дітей; педіатрична інфектологія.

Keywords: pediatric infections; acute abdomen in children; infections mimicking surgical pathology; appendicitis-like syndrome; differential diagnosis; abdominal pain in children; mesenteric lymphadenitis; bacterial gastroenteritis; viral infections; parasitic infections; management strategies in children; pediatric infectious diseases

Особливу складність для клініцистів представляють інфекційні процеси, які маскуються під хірургічні стани, такі як гострий апендицит, перитоніт, панкреатит або інфекції м'яких тканин. У таких випадках симптоматика може включати гострий біль у животі, блювання, лихоманку, підвищення маркерів запалення в крові, що створює високий ризик помилкової діагностики та непотрібного хірургічного втручання. [1]

Проблема своєчасної діагностики ускладнюється тим, що дитячий організм має специфічні реакції на інфекційний процес, включаючи виражену лімфоїдну реакцію, високу лабільність гемодинаміки та неспецифічність клінічних симптомів. [7] Крім того, деякі вірусні та бактеріальні інфекції можуть модифікувати класичну клінічну картину, імітуючи хірургічні захворювання.

Актуальність теми визначається потребою підвищення обізнаності лікарів-педіатрів та хірургів щодо клінічних форм дитячих інфекцій, які імітують хірургічні стани, та впровадження сучасних

алгоритмів діагностики й лікування, що дозволяють знизити ризик непотрібних операцій і покращити прогноз пацієнтів.

Мета статті: проаналізувати основні дитячі інфекції, що маскуються під хірургічну патологію, описати їх клінічні прояви, методи діагностики та сучасні підходи до ведення пацієнтів. [2,3]

Класифікація інфекцій, що маскуються під хірургічні стани

Інфекційні процеси в педіатричній практиці, які імітують хірургічні патології, мають високу клінічну мінливість. Для зручності розгляду їх зазвичай класифікують за трьома основними критеріями: локалізацією ураження, типом збудника та клінічною картиною.

За локалізацією ураження

*Черевна порожнина: найчастіше зустрічаються інфекції, що імітують гострий апендицит, перитоніт або холецистит. Прикладами є бактеріальні гастроентерити, вірусний мононуклеоз, цитомегаловірусна інфекція. [3]

*Грудна клітка: пневмонії та плеврити можуть проявлятися гострим болем у животі або правому

підребер'ї, що імітує хірургічну патологію печінки чи жовчного міхура.

*М'які тканини та підшкірна клітковина: інфекції шкіри та підшкірної клітковини можуть імітувати абдомінальні або загальні хірургічні стани, особливо при локалізації на передній черевній стінці або паховій ділянці. [6]

За типом збудника

*Бактеріальні інфекції: включають стафілококові, стрептококові інфекції, сальмонельоз, шигельоз, що можуть проявлятися болем у животі та симптомами перитоніту. [3]

*Вірусні інфекції: вірусний мононуклеоз, аденовірусні гастроентерити, ротавірусна інфекція, цитомегаловірус. Вони здатні викликати лімфоїдну гіперплазію та локальні запальні зміни, що імітують апендицит або панкреатит.

*Паразитарні інфекції: аскаридоз, токсокароз, ентеробіоз – можуть призводити до кишкової непрохідності або гострого болю у животі, що нагадує хірургічну патологію.

*Грибкові інфекції: у дітей раннього віку та імунокомпрометованих пацієнтів рідко, але можливі випадки інвазивного кандидозу або аспергілозу, що проявляються абдомінальною болючістю. [6]

За клінічною картиною

*Гострий біль: локалізується у правому нижньому квадранті живота (імітація апендициту), у правому підребер'ї (імітація холециститу) або по всій черевній порожнині (імітація перитоніту).

*Симптоми інтоксикації: лихоманка, блювання, анорексія, слабкість, підвищення рівнів маркерів запалення (лейкоцитоз, підвищений С-реактивний білок).

*Локальні зміни: напруження м'язів живота, позитивні симптоми подразнення очеревини, іноді поява пухлиноподібних утворень (лімфаденопатія, абсцеси). [9]

3. Основні інфекції, що маскують хірургічні стани

Дитячі інфекції, що маскують хірургічні патології, мають різноманітні клінічні прояви, що можуть суттєво ускладнювати діагностику.

Гострий апендицит-подібний синдром

Гострий біль у правому нижньому квадранті живота у дітей часто сприймається як апендицит, проте низка інфекцій можуть імітувати цю картину.

*Вірусний мононуклеоз: лімфоїдна гіперплазія в регіоні апендикса та мезентеріальних лімфовузлів може призводити до клінічної картини гострого апендициту, включаючи біль, блювання та субфебрильну температуру.

*Цитомегаловірусна інфекція: у дітей раннього віку може викликати запальні зміни в черевній порожнині та лімфаденопатію, що імітує апендицит.

*Бактеріальні гастроентерити (*Salmonella*, *Yersinia*): часто супроводжуються гострим болем у правому нижньому квадранті, лихоманкою та діареєю. *Yersinia enterocolitica*, зокрема, є класичним прикладом інфекції, що маскує апендицит. [1,2]

Клінічна відмінність цих інфекцій від справжнього апендициту полягає у наявності системних симптомів (загальна інтоксикація, ураження слизових, лімфаденопатія) та частіше відсутності чіткої локалізації болю.

Інфекції, що імітують холецистит та панкреатит

*Вірусні гастроентерити (аденовіруси, ротавіруси) та вірусні гепатити можуть проявлятися больовим синдромом у правому підребер'ї, нудотою та підвищенням печінкових ферментів, що нагадує холецистит.

Інфекції, що маскують перитоніт

Перитонітоподібні прояви у дітей можуть виникати при важких бактеріальних інфекціях кишечника та м'яких тканин. До них належать:

*Сальмонельоз із дифузним болем у животі та блюванням;

*Пневмококові та стафілококові інфекції, що супроводжуються системними проявами інтоксикації та локальною болючістю.

У цих випадках лабораторні маркери запалення (лейкоцитоз, підвищений С-реактивний білок, прокальцитонін) можуть бути значно підвищені, що імітує хірургічну патологію. [4,7]

Інфекції м'яких тканин

Целюліт та флегмона у дітей можуть проявлятися локальною болючістю, почервонінням та набряком, іноді іррадіюючи на черевну порожнину або пахову ділянку, що створює помилкову картину абдомінальної патології. Найчастіше збудниками є *Staphylococcus aureus* та *Streptococcus pyogenes*, рідше – грамнегативна флора. [6]

4. Клінічна картина та діагностика

Діагностика дитячих інфекцій, що маскуються під хірургічні стани, є складним завданням, оскільки клінічні прояви часто перекриваються зі справжньою хірургічною патологією. Точна диференціація є критичною для уникнення непотрібного хірургічного втручання та своєчасного призначення консервативної терапії.

Гострий біль у животі: локалізація болю залежить від зони ураження, найчастіше – правий нижній квадрант (імітація апендициту), епігастрій (імітація панкреатиту) або дифузний біль (імітація перитоніту).

Лихоманка та інтоксикаційний синдром: підвищення температури тіла, слабкість, блідість, анорексія. У дітей раннього віку інтоксикаційні симптоми можуть бути вираженими навіть при легких інфекціях.

Шлунково-кишкові симптоми: нудота, блювання, діарея, здуття живота. Ці прояви часто супроводжують інфекційні гастроентерити, які імітують хірургічні стани.

Локальні зміни: напруження м'язів живота, позитивні симптоми подразнення очеревини, лімфаденопатія, іноді поява пухлиноподібних утворень (пахові або мезентеріальні абсцеси). [2,5]

Лабораторні методи:

Загальний аналіз крові: може виявляти лейкоцитоз із зсувом формули вліво при бактеріальних

інфекціях; у вірусних інфекціях частіше – лімфоцитоз.

С-реактивний білок (СРБ) та прокальцитонін: підвищення цих маркерів часто спостерігається при тяжких бактеріальних інфекціях і може імітувати перитоніт.

Біохімічні показники: амілаза, ліпаза, печінкові ферменти можуть бути підвищені при вірусних гепатитах або панкреатитоподібних станах, що імітують хірургічні патології. [10,13]

Інструментальні методи:

Ультразвукове дослідження (УЗД): основний метод первинної візуалізації; дозволяє виявити апендицит, абсцеси, збільшені лімфовузли, запальні зміни печінки або жовчного міхура.

Комп'ютерна томографія (КТ): застосовується у складних випадках, коли ультразвук недостатньо інформативний; дозволяє точніше оцінити абдомінальну структуру та диференціювати інфекцію від хірургічної патології.

Магнітно-резонансна томографія (МРТ): корисна при оцінці м'яких тканин та судинних структур, особливо у дітей із складною клінічною картиною. [5]

Диференційна діагностика:

Ключовим завданням є відмежування інфекційних процесів від гострих хірургічних станів:

-Гострий апендицит vs інфекційний мононуклеоз чи *Yersinia*-ентероколіт.

-Перитоніт vs важка бактеріальна інфекція кишечника.

-Флегмона vs абдомінальний абсцес.

Системний підхід, що поєднує клінічні дані, лабораторні показники та інструментальні методи, дозволяє знизити ризик помилкових діагнозів та непотрібних операцій, що особливо важливо в педіатрії. [11]

5. Тактика ведення

Ведення дітей із інфекціями, що маскують хірургічну патологію, вимагає обережного та системного підходу, поєднання педіатричної та хірургічної методик, а також використання сучасних протоколів консервативного лікування. Основна мета – зменшити ризик непотрібної операції, запобігти прогресуванню інфекції та мінімізувати ускладнення. [2]

Консервативне лікування

Постільний режим та контроль інтоксикації: у дітей із помірною інтоксикацією рекомендовано обмеження фізичних навантажень та підтримку водно-електролітного балансу.

Регуляція гідратації: при блюванні або діарейі важливо проводити корекцію втрат рідини за допомогою пероральної регідратації або внутрішньовенного введення ізотонічних розчинів.

Симптоматична терапія: знеболювальні препарати (переважно парацетамол) та жарознижуючі засоби застосовуються за потреби, з урахуванням віку та маси дитини. [7]

Антибіотикотерапія

Антибіотики призначаються за показаннями, залежно від тяжкості стану та типу інфекційного збудника:

-Бактеріальні інфекції: у разі підозри на тяжкий бактеріальний процес (сальмонельоз, стафілокова чи стрептокова інфекція) призначаються антибіотики широкого спектра дії, з урахуванням протоколів. Наприклад: цефалоспорины III покоління або амоксицилін/клавуланат.

-Вірусні інфекції: специфічна антивірусна терапія призначається лише за наявності клінічних показань (наприклад, тяжкий вірусний гепатит, цитомегаловірусна інфекція). [4,8]

-Паразитарні інфекції: призначення антигельмінтичних засобів (альбендазол, мебендазол) здійснюється після підтвердження діагнозу лабораторними або інструментальними методами.

Показання до хірургічного втручання

Хірургічне втручання показане лише у випадках, коли консервативне ведення неефективне або виникають життєво загрозові ускладнення:

-Підозра на гострий апендицит із перфорацією.

-Перитоніт із септичними проявами, що не піддається антибіотикотерапії.

-Абсцеси, некротичні ураження м'яких тканин або кишкова непрохідність при паразитарних інфекціях.

Перед прийняттям рішення про операцію обов'язково є консультація педіатра та дитячого хірурга, оцінка лабораторних даних, ультразвукового або комп'ютерного обстеження. Таке поєднання підходів дозволяє мінімізувати ризик непотрібних втручань та покращити клінічний прогноз. [1,9]

Алгоритм ведення

-Першочергова оцінка стану: визначення ступеня інтоксикації, локалізації болю, наявності системних ознак.

-Лабораторна та інструментальна діагностика: загальний аналіз крові, СРБ, УЗД черевної порожнини.

-Початок консервативної терапії: регідратація, симптоматичне лікування, антибіотики за показаннями.

-Моніторинг: динаміка симптомів, лабораторних та інструментальних показників.

-Хірургічне втручання: при прогресуванні або ускладненнях. [1]

6. Ускладнення та прогноз

Дитячі інфекції, що маскуються під хірургічні стани, мають потенційно серйозні наслідки у разі неправильної діагностики або несвоєчасного лікування. [10]

Основні ускладнення:

Непотрібне хірургічне втручання:

-Проведення лапаротомії або апендектомії при апендицитоподібних інфекціях, які могли б бути успішно вилікуватись консервативно.

Підвищений ризик післяопераційних ускладнень:

-інфекційні післяопераційні ускладнення, адгезії, порушення травлення.

Прогресування інфекції:

-За відсутності адекватної антибіотикотерапії або підтримувальної терапії можливий розвиток генералізованої інфекції, сепсису або абсцесів черевної порожнини.

-У дітей раннього віку та з імунodefіцитами підвищується ризик системних ускладнень навіть при помірно тяжкій інфекції.

Хронізація процесу:

Деякі вірусні або паразитарні інфекції, що мають хірургічну патологію, можуть призводити до хронічного запалення лімфовузлів, печінки або кишечника, що вимагає тривалого спостереження та повторних госпіталізацій. [3,6]

Прогноз залежить від декількох ключових аспектів:

-Своєчасність та точність діагностики: раннє виявлення інфекційного процесу від хірургічного стану зменшує ризик непотрібних операцій і післяопераційних ускладнень.

-Адекватність терапії: своєчасне застосування антибіотиків, регідратації та підтримувальних заходів знижує частоту ускладнень.

-Вік та імунний статус дитини: немовлята та діти з імунodefіцитами мають вищий ризик тяжких форм інфекцій та ускладнень.

-Наявність супутньої патології: хронічні хвороби печінки, серця або шлунково-кишкового тракту можуть погіршувати прогноз. [5]

Ретельний підхід до ведення таких пацієнтів дозволяє:

-Мінімізувати ризик непотрібних операцій.

-Попередити генералізацію інфекційного процесу та тяжкі ускладнення.

-Зменшити тривалість госпіталізації та покращити якість життя пацієнта.

7. Висновки

Дитячі інфекції, що маскуються під хірургічні стани, становлять важливу проблему сучасної педіатрії та дитячої хірургії. Аналіз всього вище зазначеного дозволяє зробити наступні висновки: [12]

Висока клінічна мінливість. Інфекційні процеси у дітей можуть імітувати апендицит, перитоніт, холецистит, панкреатит та патологію м'яких тканин, що ускладнює своєчасну діагностику та підвищує ризик непотрібних хірургічних втручань.

Різноманітність збудників. Патологію можуть спричиняти бактеріальні (*Salmonella*, *Staphylococcus aureus*, *Streptococcus pyogenes*), вірусні (Epstein-Barr virus, аденовіруси, ротавірус), паразитарні (аскаридоз, ентеробіоз) та рідко грибкові інфекції.

Своєчасна діагностика. Ключовим елементом успішного ведення є комплексна оцінка клінічних проявів, лабораторних маркерів запалення та інструментальних даних (ультразвукове дослідження, комп'ютерна томографія, МРТ). Такий підхід дозволяє відрізнити інфекційні процеси від хірургічних патологій та уникнути непотрібних операцій. [13,15]

Консервативне ведення. Більшість інфекцій потребує підтримувальної терапії та антибіотикотерапії за показаннями, а хірургічне втручання показане лише при прогресуванні процесу або розвитку ускладнень.

Прогноз та профілактика ускладнень. При своєчасній та адекватній діагностиці прогноз сприятливий. Основними факторами ризику ускладнень є затримка діагностики, тяжкість інфекційного процесу та наявність імунodefіцитів.

Таким чином, підвищення обізнаності лікарів-педіатрів та дитячих хірургів, використання системного підходу до діагностики та дотримання сучасних алгоритмів лікування є ключовими факторами для зменшення частоти ускладнень і покращення клінічного прогнозу дітей із інфекціями, що імітують хірургічні стани. [10,11]

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SIMULATION MEDICINE IN MEDICAL AND PHARMACY EDUCATION: A COMPREHENSIVE REVIEW

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СИМУЛЯЦІЙНА МЕДИЦИНА В МЕДИЧНІЙ ТА ФАРМАЦЕВТИЧНІЙ ОСВІТІ: КОМПЛЕКСНИЙ ОГЛЯД

Abstract

Simulation-based medicine represents a transformative approach in medical and pharmacy education, providing a risk-free environment for developing clinical and pharmaceutical skills. This comprehensive review examines current simulation methods, including high-fidelity mannequins, virtual reality (VR), augmented reality (AR), and pharmacy simulation laboratories. According to Sitsinska et al. (2023), simulation enhances skill acquisition, reduces errors, and improves confidence. Bodnar et al. (2022) emphasize its role in integrating practical and theoretical knowledge, while Hrynychuk et al. (2023) highlight the importance of interprofessional and interdisciplinary training. The paper also presents a detailed analysis of the advantages and limitations ("Pros and Cons") of simulation-based learning, comparing it with traditional educational approaches.

Анотація

Симуляційна медицина являє собою трансформаційний підхід у медичній та фармацевтичній освіті, забезпечуючи безпечне середовище для розвитку клінічних та фармацевтичних навичок. У цьому комплексному огляді розглядаються сучасні методи симуляції, включаючи високоточні манекени, віртуальну реальність (VR), доповнену реальність (AR) та фармацевтичні симуляційні лабораторії. За даними Сіцинської та ін. (2023), симуляція покращує набуття навичок, зменшує кількість помилок та підвищує впевненість. Боднар та ін. (2022) підкреслюють її роль в інтеграції практичних та теоретичних знань, тоді як Гринчук та ін. (2023) підкреслюють важливість міжпрофесійного та міждисциплінарного навчання. У статті також представлено детальний аналіз переваг та обмежень («За та проти») навчання на основі симуляції, порівнюючи його з традиційними освітніми підходами.

Keywords: simulation medicine, medical education, pharmacy education, virtual reality, augmented reality, clinical skills, competency-based training.

Ключові слова: симуляційна медицина, медична освіта, фармацевтична освіта, віртуальна реальність, доповнена реальність, клінічні навички, навчання на основі компетенцій.

Introduction

Medical and pharmacy education is undergoing rapid transformation due to increasing patient safety standards, technological advancements, and the rising complexity of healthcare practice. Traditional educational methods, relying primarily on lectures and bedside teaching, are often insufficient for preparing students to perform complex clinical and pharmaceutical tasks safely (Sitsinska et al., 2023).

Simulation-based learning offers a controlled and interactive environment that allows students to repeatedly practice clinical procedures and pharmaceutical interventions without risk to patients. It provides immediate feedback, promotes critical thinking, and develops decision-making skills, all of which are essential for modern healthcare professionals. Bodnar et al.

(2022) note that simulation is particularly effective for high-stakes procedures, rare clinical scenarios, and interprofessional education, while Hrynychuk et al. (2023) underscore the role of digital technologies such as VR and AR in enhancing realism and engagement.

The increasing prevalence of simulation-based education worldwide reflects its growing recognition as an essential component of competency-based medical and pharmacy curricula.

Aim of the Study

This review aims to:

1. Analyze current simulation methods in medical and pharmacy education;
2. Evaluate the effectiveness of simulation-based learning compared to traditional methods;

3. Examine the advantages and limitations of simulation education (“Pros and Cons”);

4. Provide recommendations for the integration of simulation into modern healthcare curricula.

Materials and Methods

A systematic literature review was conducted using PubMed, Scopus, and Google Scholar databases for publications from 2018 to 2024. Search terms included: “simulation-based medical education,” “pharmacy simulation,” “virtual reality medical training,” “augmented reality in healthcare education,” and “interprofessional simulation.”

The methodology included:

- Comparative analysis of traditional versus simulation-based educational outcomes (Sitsinska et al., 2023);
- Review of high-fidelity mannequins, VR, and AR applications in medical and pharmacy education (Bodnar et al., 2022);
- Evaluation of interdisciplinary and interprofessional simulation programs (Hrynychuk et al., 2023);
- Identification of advantages and limitations through qualitative and quantitative studies.

Results and Discussion

1. Simulation Methods

Aspect	Pros	Cons
Safety	Eliminates risk to patients (Sitsinska et al., 2023)	Students may develop overconfidence without real patient interaction
Skill acquisition	Accelerates procedural learning and improves retention	High costs for equipment and maintenance (Hrynychuk et al., 2023)
Error management	Allows repeated practice and correction of mistakes	Limited realism for some complex or unpredictable clinical scenarios
Technological integration	VR and AR enhance engagement, understanding, and critical thinking	Requires trained faculty and technical support
Interprofessional collaboration	Enhances teamwork and communication skills	Scheduling and coordination challenges in multidisciplinary programs
Accessibility	Allows learning outside traditional clinical settings	Resource-intensive; may not be equally available to all institutions

3. Comparative Effectiveness

According to Sitsinska et al. (2023) and Bodnar et al. (2022), simulation-trained students demonstrate:

- Higher procedural accuracy;
- Faster skill acquisition;
- Reduced clinical errors;
- Greater confidence in performing high-stakes procedures.

Simulation also supports cognitive skill development, including clinical reasoning, decision-making, and ethical judgment. Hrynychuk et al. (2023) report that VR/AR-based simulations improve engagement and long-term knowledge retention.

4. Limitations and Challenges

Despite its advantages, simulation education faces challenges:

- High initial setup and maintenance costs;
- Need for continuous faculty training;
- Potential gaps between simulated and real patient responses;
- Limited access in resource-constrained settings.

High-Fidelity Mannequins: Provide realistic clinical scenarios including airway management, CPR, and critical care procedures. Students can practice invasive procedures safely and receive immediate feedback.

Virtual Reality (VR): Creates immersive, interactive environments that replicate complex clinical cases. VR is particularly useful for rare or high-risk scenarios, allowing repeated practice without patient risk.

Augmented Reality (AR): Superimposes digital information onto the physical world, enhancing anatomical visualization, procedural guidance, and pharmaceutical training simulations.

Pharmacy Simulation Labs: Focus on compounding medications, performing pharmacokinetic calculations, patient counseling, and clinical decision-making. Students can experience real-world scenarios such as drug-drug interactions and adverse event management.

Integration in Interprofessional Education: Simulation promotes collaboration between medical and pharmacy students, preparing them for team-based patient care.

2. Pros and Cons of Simulation-Based Education

Nevertheless, proper curriculum design and integration can mitigate many of these challenges, maximizing educational outcomes.

5. Future Directions

- Expansion of VR and AR tools with artificial intelligence for adaptive scenarios;
- Broader implementation of interprofessional simulation programs;
- Development of standardized assessment tools for competency evaluation;
- Research on long-term impact of simulation-based learning on patient outcomes.

Conclusion

1. Simulation-based education is a highly effective tool for developing clinical and pharmaceutical competencies (Sitsinska et al., 2023).

2. High-fidelity mannequins, VR, AR, and pharmacy simulation labs improve skill acquisition, reduce errors, and enhance confidence.

3. Advantages include safety, repeatable practice, and interdisciplinary learning; limitations involve cost, technical requirements, and potential gaps from

real-life variability (Bodnar et al., 2022; Hrynychuk et al., 2023).

4. Strategic integration of simulation into medical and pharmacy curricula is essential for preparing competent healthcare professionals.

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EARTH SCIENCES

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ВЛИЯНИЕ НАУЧНОЙ КОММУНИКАЦИИ НА РАЗВИТИЕ ЭКОЛОГИИ

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THE IMPACT OF SCIENTIFIC COMMUNICATION ON THE DEVELOPMENT OF ECOLOGY

Аннотация

Статья посвящена роли научной коммуникации в развитии экологии как научной дисциплины и практической сферы. Показано, как распространение научных знаний выходит за пределы академической среды, формируя общественный запрос и поддерживая принятие политических решений по экологическим вопросам. Рассматриваются механизмы взаимодействия учёных, СМИ, органов власти и общества, а также эволюция экологической коммуникации, её инструменты и каналы. Обосновывается, что эффективная научная коммуникация связывает результаты исследований с регуляторными мерами и устойчивыми поведенческими практиками, при этом требует адаптации сложного содержания для разных аудиторий. Сделан вывод о необходимости интеграции научной коммуникации в экологические исследования и политику как условия перехода к устойчивому развитию.

Abstract

The article examines the role of scientific communication in the development of ecology as both a scientific discipline and a practical field of activity. It demonstrates how the dissemination of scientific knowledge extends beyond the academic environment, shaping public demand and supporting policymaking in the field of environmental protection. The mechanisms of interaction among scientists, mass media, governmental bodies, and society are analyzed, along with the evolution of environmental communication, its tools, and channels. The study substantiates that effective scientific communication links research outcomes with regulatory measures and sustainable behavioral practices, while requiring the adaptation of complex content for diverse audiences. It concludes that the integration of scientific communication into environmental research and policy is a necessary condition for the transition to sustainable development.

Ключевые слова: научная коммуникация, экология, экологическая коммуникация, СМИ, общественное сознание, экологическая политика, устойчивое развитие, популяризация науки.

Keywords: scientific communication, ecology, environmental communication, mass media, public awareness, environmental policy, sustainable development, science popularization.

В условиях нарастающего глобального экологического кризиса, проявляющегося в изменении климата, утрате биоразнообразия и загрязнении окружающей среды, значение достоверного научного знания приобретает критическую важность. Однако сами по себе научные открытия и модели, оставаясь в стенах лабораторий и специализированных журналов, не способны изменить траекторию развития общества. Именно научная коммуникация выступает тем незаменимым мостом, который соединяет мир науки с миром политики, бизнеса и гражданского общества, обеспечивая перевод сложных концепций на язык практических решений. Без эффективных механизмов такой коммуникации даже самые убедительные научные доказательства рискуют остаться невостребованными, что ставит под угрозу возможность своевременного и адекватного реагирования на вызовы планетарного масштаба.

Современный этап развития экологии характеризуется возрастающей сложностью исследуемых

проблем, что, в свою очередь, предъявляет новые требования к способам передачи информации. Как отмечает Е.В. Панова, экологическая коммуникация, тесно переплетаясь с научной, прошла значительный путь становления, выделившись в самостоятельную область, которая фокусируется не только на передаче фактов, но и на формировании ценностей и моделей поведения [3, с. 6]. В этом контексте актуальным становится исследование конкретных механизмов, через которые научная коммуникация влияет на экологическую политику, общественное мнение и, в конечном итоге, на состояние окружающей среды. Понимание этих механизмов позволяет оптимизировать коммуникационные стратегии и повысить их эффективность в деле охраны природы.

В современном мире, где информационный поток невероятно плотен, а внимание аудитории рассеяно, задача донесения научных экологических знаний становится особенно сложной. Научная коммуникация в экологической сфере перестала

быть факультативной деятельностью и превратилась в профессиональную необходимость, требующую от исследователей освоения новых навыков работы с медиа и общественностью. Этот императив диктуется как остротой экологических проблем, так и демократизацией процесса принятия решений, когда общественное согласие становится ключевым фактором для запуска масштабных преобразований.

Влияние научной коммуникации на развитие экологии начинается с фундаментальной задачи легитимации научного знания в публичном пространстве. В ситуации, когда по многим вопросам, таким как антропогенное изменение климата или последствия использования пластика, в общественном дискурсе могут циркулировать противоположные точки зрения, именно качественная коммуникация призвана четко обозначить научный консенсус. Она обеспечивает разграничение между научно обоснованными фактами и субъективными мнениями или дезинформацией, которая часто имеет политическую или коммерческую подоплеку. Укрепляя доверие к науке, коммуникаторы создают прочную основу для дальнейшего диалога, без которой любые призывы к действию будут встречать сопротивление или непонимание. Этот процесс требует постоянной, системной работы по разъяснению методологии исследований, принципов работы научного сообщества и сути полученных выводов [5, с. 33].

Особую роль в этом процессе играют средства массовой информации, выступающие в качестве основного канала трансляции научных знаний для широкой аудитории. О.О. Минаева подчеркивает, что СМИ не просто информируют общество об экологических проблемах, но и активно участвуют в формировании экологического сознания, расставляя акценты и определяя приоритеты в повестке дня [2, с. 338]. От того, как журналисты интерпретируют пресс-релизы научных институтов, насколько глубоко погружаются в контекст и проверяют информацию, зависит итоговый образ проблемы в глазах обывателя. Качественная журналистика, основанная на доказательных данных, способна мобилизовать общественное мнение и создать давление на власти, в то время как поверхностное или сенсационное освещение может привести к искажению фактов и росту скептицизма. Таким образом, СМИ являются не пассивным передатчиком, а активным конструктором экологической реальности, воспринимаемой обществом.

Одним из ключевых направлений влияния является формирование и коррекция государственной экологической политики. Решения на государственном уровне, будь то введение новых нормативов выбросов, создание охраняемых природных территорий или инвестиции в зеленые технологии, должны опираться на надежные научные данные. Задача научной коммуникации в этой сфере – обеспечить доступ лиц, принимающих решения, к актуальным и верифицированным знаниям в адаптированной, но не упрощенной форме. Это происходит

через экспертные заключения, участие ученых в рабочих группах и комитетах, публикацию докладов для органов власти. Когда научные аргументы ясно и убедительно интегрированы в политический дискурс, они минимизируют влияние лоббистских групп и повышают шансы на принятие мер, действительно направленных на долгосрочное устойчивое развитие. Без этого связующего звена политика рискует стать реактивной и конъюнктурной.

На уровне местных сообществ научная коммуникация приобретает особую практическую значимость, трансформируясь в инструмент решения конкретных проблем. Например, разъяснение данных о качестве питьевой воды, уровнях шума или загрязнения воздуха в конкретном районе позволяет жителям осознать риски и аргументированно отстаивать свои права. Совместная работа ученых и активистов над сбором и интерпретацией данных (гражданская наука) усиливает потенциал общественного контроля за состоянием окружающей среды. Просветительские проекты, такие как публичные лекции, экскурсии или мастер-классы, не только информируют, но и способствуют формированию локальных инициатив по озеленению, раздельному сбору отходов или сохранению природных уголков. Таким образом, наука перестает быть абстракцией, а становится частью повседневной жизни, инструментом защиты здоровья и качества среды обитания.

Важнейшим аспектом является этическое измерение научной коммуникации в столь чувствительной сфере, как экология. Коммуникатор несет ответственность за точность передаваемой информации, баланс между необходимостью донести серьезность ситуации и избежать фатализма, который парализует волю к действию. Нельзя допускать упрощений, искажающих смысл исследования, или спекуляций на теме страха. Как отмечает Е.В. Панова, экологическая коммуникация все более осознает свою роль не просто как передатчика фактов, а как участника формирования новой экологической этики и культуры [4, с. 770]. Это накладывает обязательство на коммуникатора тщательно взвешивать последствия своих сообщений, стремиться к диалогу, а не монологу, и признавать существование неопределенностей в науке, не используя их как повод для бездействия. Честность и прозрачность становятся ключевыми валютами доверия.

Я.В. Евсеева указывает на то, что современная научная коммуникация существует в условиях трансформации самой науки, которая становится более открытой, инклюзивной и социально ориентированной [1, с. 15]. Эта трансформация отчетливо видна в экологии, где многие проблемы не имеют чисто технических решений, а требуют учета социальных, экономических и культурных факторов. Коммуникация в таком контексте – это не просто линейная передача информации «от знающего к незнающему», а сложный диалог, в котором общество не является пассивным объектом просвещения, а активным соучастником в определении путей развития. Признание этого факта меняет роль ученого-коммуникатора, который становится модератором

общественного обсуждения, помогая наводить мосты между различными формами знания – академическим, экспертно-прикладным, местным, традиционным.

Препятствиями на пути эффективной коммуникации остаются терминологические барьеры, академическая культура, не всегда поощряющая публичную активность, и ограниченность ресурсов. Многие исследователи не имеют специальной подготовки в области коммуникации и могут чувствовать себя неуверенно, выходя за пределы профессионального круга. Кроме того, существует объективное противоречие между необходимостью оперативно реагировать на запросы СМИ и тщательностью, неторопливостью научного процесса. Преодоление этих барьеров требует системных усилий со стороны научных институтов: создания внутренних служб поддержки (пресс-служб, отделов по связям с общественностью), включения коммуникационных тренингов в программы подготовки аспирантов, а также формального признания просветительской деятельности как значимого компонента научной работы при оценке карьерных достижений.

Таким образом, научная коммуникация является не вспомогательным, а конституирующим элементом в развитии современной экологии. Она выполняет многогранную функцию: от легитимации научного знания в публичном пространстве и формирования экологической политики до воспитания новой культуры потребления и стимулирования технологических инноваций. Экологическая коммуникация, выросшая из научной, сегодня играет

самостоятельную роль в структурировании общественного диалога о будущем планеты. В условиях, когда экологические вызовы носят глобальный и комплексный характер, способность ясно, точно и убедительно транслировать научные данные становится критически важным социальным навыком. Таким образом, инвестиции в развитие инфраструктуры и компетенций в области научной коммуникации должны рассматриваться как стратегический вклад не только в прогресс экологической науки, но и в обеспечение устойчивого и безопасного развития человеческой цивилизации в целом.

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ЭРОЗИЯ ПОЧВЫ И ЕЕ ВОЗДЕЙСТВИЕ НА ПРИРОДНЫЕ ЛАНДШАФТЫ

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SOIL EROSION AND ITS IMPACT ON NATURAL LANDSCAPES

Аннотация

В статье рассматриваются основные виды эрозии, их движущие силы и специфическое воздействие на различные компоненты ландшафта, такие как рельеф, гидрологический режим и растительный покров. Особое внимание уделяется анализу последствий эрозии для агрохимических свойств почв, включая потерю гумуса и питательных элементов. На основе современных исследований обобщаются ключевые антропогенные факторы, усугубляющие этот процесс, такие как нерациональное землепользование и вырубка лесов. В работе также оцениваются перспективные методы борьбы с эрозией, направленные на адаптацию хозяйственной деятельности и восстановление нарушенных земель. Комплексный подход к решению проблемы эрозии является необходимым условием для обеспечения устойчивого развития территорий и сохранения природного капитала.

Abstract

The article examines the main types of soil erosion, their driving forces, and their specific impact on various landscape components, such as relief, hydrological regime, and vegetation cover. Particular attention is paid to the analysis of the consequences of erosion for the agrochemical properties of soils, including the loss of humus and essential nutrients. Based on contemporary research, the key anthropogenic factors that intensify this process are summarized, including irrational land use and deforestation. The study also evaluates promising erosion control methods aimed at adapting economic activities and restoring degraded lands. A comprehensive approach to addressing the problem of erosion is a necessary condition for ensuring sustainable territorial development and preserving natural capital.

Ключевые слова: эрозия почв, деградация земель, природные ландшафты, водная эрозия, агрохимические свойства, севооборот, антропогенное воздействие, противоэрозионные мероприятия, ландшафтное планирование.

Keywords: soil erosion, land degradation, natural landscapes, water erosion, agrochemical properties, crop rotation, anthropogenic impact, anti-erosion measures, landscape planning.

Эрозия почв давно перестала быть сугубо агрономической или локальной проблемой. Сегодня ее масштабы превратили процесс в один из центральных вызовов для устойчивости сельского хозяйства и экосистем в целом. Интенсификация землепользования, растущая антропогенная нагрузка на ландшафты и изменение климатических паттернов действуют синергетически, лавинообразно ускоряя снос плодородного слоя. Деградация земель, запущенная эрозией, не просто снижает урожайность – она вынуждает к постоянному наращиванию затрат на мелиорацию и удобрения, подрывая экономическую основу целых регионов.

Глубина трансформаций, инициируемых эрозией в природных ландшафтах, определяет непреходящую актуальность ее изучения. Процесс разрывает многовековые связи между рельефом, почвой, водой и биотой, часто необратимо. Результатом становится упрощение экосистем, потеря их способности к саморегуляции. Понимание этих механизмов необходимо для разработки не только теоретических моделей, но и практических

систем землепользования, способных адаптироваться к рискам, для планирования восстановления нарушенных территорий.

Под эрозией понимают разрушение и перенос верхнего почвенного слоя – мощный фактор преобразования земной поверхности. Ее интенсивность варьирует в зависимости от зональных условий, но движущей силой всегда выступает энергия природных агентов: дождевых капель, водного потока, ветра. Однако геологическая, или естественная, эрозия, скорость которой сопоставима с почвообразованием, сегодня повсеместно замещена эрозией ускоренной, антропогенной. Скорость последней на порядки превышает скорость формирования нового почвенного профиля. Поскольку почва в человеческом временном масштабе – ресурс невозобновимый, ее ускоренная потеря создает прямую угрозу основам биосферной и социальной стабильности.

Наиболее разрушительной и распространенной формой признается водная эрозия, особенно в условиях расчлененного рельефа и ливневых осад-

ков. Механизм эрозии, как указывает У.З. Акперова, начинается с кинетического удара капель дождя, который разрушает почвенные агрегаты, вызывая их распыление и закупорку пор [1]. Последующий непроницаемый сток концентрируется в ручейки, начинающие линейный размыв с образованием промоин, а затем и оврагов. Помимо прямого уничтожения пашни, это коренным образом перестраивает микрорельеф, создавая густую сеть бесполезных для хозяйства рытвин. Тонкодисперсная фракция почвы, наиболее обогащенная гумусом и элементами питания, безвозвратно выносятся из корнеобитаемой зоны; ее аккумуляция в понижениях или водоемах приводит к заилению, засасыванию прудов и рек.

Почвенный покров как базовый компонент ландшафта подвергается прямой деградации. Мощность гумусовых горизонтов неуклонно сокращается, что лишает среду обитания ее основного ресурса. Исследования О.Э. Хакбердиева и Т.Ш. Шамсиддинова демонстрируют, как эрозия ухудшает агрохимические показатели [5]. В первую очередь теряются наиболее лабильные и ценные формы элементов питания: нитратный и аммонийный азот, легкодоступные фосфор и калий. Следом снижаются емкость катионного обмена и буферная способность, почва закисляется, теряет устойчивость к дальнейшим химическим нагрузкам. Деградируют и физические свойства: разрушается водопропрочная структура, растет плотность сложения, падает влаго- и воздухоемкость.

Антропогенный фактор стал главным катализатором эрозии. Классический пример – сплошные рубки леса, радикально меняющие водный и тепловой баланс территории, обнажающие почву и лишаящие ее укрепляющей функции корневых систем. К.В. Астапкович и Л.Ю. Геваргис фиксируют резкий рост поверхностного стока и смыва даже на пологих, ранее стабильных склонах после вырубки [2]. На крутых склонах и в водоохранных зонах рубки часто запускают неконтролируемую линейную эрозию и оползни. Восстановление исходного состояния в таких случаях требует десятилетий и огромных затрат.

Нерациональная агротехника является вторым мощным фактором. Распашка вдоль склона создает идеальные пути для концентрации стока. Длительное возделывание пропашных культур, оставляющих почву без защиты, отсутствие мульчи, переупас, уничтожающий дернину, все это ослабляет естественную сопротивляемость. Интенсивная механизация формирует плужную подошву, переуплотняет подпахотный горизонт и блокируя инфильтрацию. Таким образом, сельское хозяйство оказывается в двойственной роли: оно является главным пострадавшим и основным источником эрозионной опасности.

В этих условиях требуется кардинальный пересмотр подходов к проектированию агросистем. Н.С. Бутенин справедливо указывает, что севооборот в эрозионно-опасных условиях должен минимизировать период отсутствия растительного покрова [3]. Этого достигают включением в ротацию

многолетних бобово-злаковых трав, создающих плотную дернину и улучшающих структуру почвы. Сидерация, промежуточные и покровные культуры позволяют сохранять «зеленый покров» практически круглогодично, гася ударную энергию дождевых капель и талых вод.

Оценка масштабов и разработка контрмер невозможны без современных методов диагностики. Полевые методы – разрезы, стоковые площадки – остаются основой для точных количественных данных. Однако, как отмечает В.А. Спиридонычев, возрастает роль дистанционных и геофизических методов [4, с. 379]. Спутниковый мониторинг и аэрофотосъемка оперативно выявляют очаги эрозии и картографируют риски. Георадар и электро-томография позволяют оценить мощность смытого слоя и строение подстилающих пород без масштабных земляных работ.

Последствия эрозии выходят за пределы суши, затрагивая водные экосистемы. Твердый сток, основной источник которого – смытая почва, ведет к заилению русел, озер, водохранилищ. Это сокращает их полезный объем, осложняет судоходство, повышает паводковую опасность. Взвешенные наносы резко снижают прозрачность воды, угнетая развитие фитопланктона – основы трофической цепи. Оседая, они разрушают нерестилища, заиливают донные биоценозы. Кроме того, с почвенными частицами в водоемы поступают сорбированные пестициды и удобрения, вызывая эвтрофикацию и токсическое загрязнение.

Климатические изменения выступают как риск-мультипликатор. Прогнозируемый рост интенсивности ливней напрямую увеличивает энергию дождевых капель и объемы стока. Учащение засух, наоборот, иссушает почву, разрушает структуру, делая ее более уязвимой к последующему размыву. Таяние мерзлоты и сдвиги в режиме снеготаяния активизируют криогенные и склоновые процессы. Климат становится дополнительным драйвером эрозии, что требует коррекции существующих защитных стратегий с учетом долгосрочных сценариев.

Экономические последствия носят кумулятивный и часто скрытый характер. Прямые убытки – потеря урожая, затраты на дополнительные удобрения, расчистку каналов и водоемов. Косвенные могут быть масштабнее: снижение продуктивности экосистем, потеря биоразнообразия, учащение и усиление паводков, затраты на ликвидацию оползней, падение стоимости земель. В глобальном контексте эрозия угрожает продовольственной безопасности, особенно в странах с ограниченными ресурсами для противоэрозионных мер.

Противодействие эрозии требует междисциплинарного подхода, синтезирующего методы почвоведения, агрономии, лесоводства, гидрологии. Необходим переход от отраслевого к ландшафтно-экологическому управлению, когда хозяйственная деятельность проектируется исходя из устойчивости конкретных типов местности. Инструментом такого перехода могут стать системы точного зем-

леделия, позволяющие дифференцированно обрабатывать поля с учетом рельефа, свойств почвы и степени риска.

Правовое и институциональное сопровождение следует рассматривать как обязательный элемент системы противоэрозионного управления. Необходимо дальнейшее совершенствование земельного и природоохранного законодательства, включая уточнение требований и усиление режимов регулирования для территорий с повышенной степенью риска деградации. Применение экономических механизмов, в том числе платы за деградацию земель, а также предоставление субсидий и налоговых преференций субъектам, внедряющим почвозащитные технологии, способно ускорить переход к устойчивым практикам землепользования. Формирование открытой и регулярно обновляемой системы мониторинга состояния земель создаст доказательную базу для принятия управленческих решений на муниципальном, региональном и федеральном уровнях.

Просветительская работа должна сформировать новое отношение к почве как к уязвимому и живому наследию. Понимание эрозионных процессов должно стать частью экологического образования. Критически важно демонстрировать фермерам и землеустроителям экономическую целесообразность профилактических мер: первоначальные вложения окупаются сохранением плодородия и устойчивости производства в среднесрочной перспективе. Обмен опытом, демонстрационные площадки, консультационные службы способны стать катализаторами изменений.

Перспективы связаны с внедрением инновационных технологий. Это новые покровные культуры с мощной корневой системой, биополимеры для временного закрепления почв, дроны для мониторинга и точечного применения средств защиты. Большой потенциал у агролесоводства, интегрирующего деревья и кустарники в сельскохозяйственные ландшафты.

Таким образом, эрозия почв является не локальным явлением, а одним из ключевых факторов преобразования природных ландшафтов. Ее влияние носит системный и каскадный характер: стартуя с деградации почвенного покрова и морфологических изменений рельефа, процесс затрагивает

водный режим территорий, состояние биоразнообразия и устойчивость экосистем в целом. Определяющим фактором ускорения эрозионных процессов выступает антропогенная нагрузка, прежде всего связанная с нерациональными практиками в сельском и лесном хозяйстве. Эффективное противодействие возможно при переходе к адаптивной модели ландшафтно-экологического управления, опирающейся на сочетание агротехнических, лесомелиоративных и инженерно-технических решений. Результативность таких мер в значительной степени определяется интеграцией современных инструментов мониторинга, развитием правовых и экономических механизмов регулирования, а также расширением международного научного и практического взаимодействия. Сохранение почвенного покрова как стратегического природного ресурса достижимо лишь при комплексном и междисциплинарном подходе.

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PEDAGOGICAL SCIENCES

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METHODOLOGICAL FRAMEWORK FOR THE DEVELOPMENT OF REFLECTIVE COMPETENCE AMONG IN-SERVICE TEACHERS

Abstract.

The growing emphasis on reflective practice within contemporary educational reforms has intensified the need for methodological approaches that foster teachers' reflective competence in systems of continuous professional development. Modern teacher education no longer focuses solely on updating methodological knowledge; it also requires educators to critically analyse, regulate, and improve their professional activity through systematic reflection. The purpose of this study is to provide a theoretical justification and structural organization of the methodological conditions necessary for developing reflective competence among in-service teachers within the framework of continuous professional development. The research particularly addresses the professional growth of practicing English language teachers and highlights the role of reflection-oriented learning environments in strengthening professional awareness and pedagogical self-regulation. The theoretical foundation of the study integrates classical and contemporary concepts of reflective thinking, experiential learning, adult education, and social learning theories. Based on theoretical synthesis and modelling, the study proposes an integrated model aimed at supporting the development of teachers' reflective competence. Within this framework, three interrelated groups of methodological conditions are identified: organizational-pedagogical, psychological-pedagogical, and didactic conditions. These conditions are operationalized through a staged model of professional development consisting of preparatory, implementation, and reflective-evaluative phases. The model emphasises the facilitative role of trainers, the creation of a psychologically safe learning environment, and the systematic application of reflection-based pedagogical strategies, including collaborative dialogue, reflective journals, micro-teaching sessions, and video-assisted lesson analysis. The practical significance of the study lies in its applicability for improving teacher professional development programmes. The proposed model may serve as a methodological guideline for training institutions, professional development providers, and educational authorities seeking to strengthen the reflective capacity of English language teachers within ongoing professional learning systems.

Key words: reflective competence; teacher professional development; methodological framework; reflective learning environment; adult education; in-service teacher education; Uzbekistan.

Introduction. In the process of ongoing modernization of educational systems worldwide, particular attention is increasingly directed toward improving the quality of continuous professional development for teachers. Contemporary educational reforms highlight not only the necessity of updating subject knowledge and instructional methodologies, but also the importance of strengthening teachers' professional independence, critical thinking abilities, and capacity for conscious self-analysis of their pedagogical practice. Within this perspective, reflective competence is progressively recognized as a fundamental element of teacher professionalism and an essential condition for long-term professional development.

Studies in pedagogy and teacher education demonstrate that the mere accumulation of teaching experience does not inevitably result in professional growth. Practical experience becomes a meaningful source of professional learning only when it is systematically examined, critically analyzed, and reconsidered. In the absence of reflective processes, teachers often rely on routine practices and established habits, which can restrict their ability to respond effectively to evolving educational demands, updated curricular frameworks, and innovative pedagogical approaches. Consequently, reflection performs a transformative function by converting professional experience into

structured knowledge and supporting the continuous refinement of teaching practice.

The conceptual foundations of reflective learning originate in the work of John Dewey, who defined reflective thinking as an active and deliberate intellectual process closely linked with experience and problem solving. Subsequently, David Schön expanded this perspective by introducing the notions of "reflection-in-action" and "reflection-on-action," emphasizing that professional learning emerges through the critical analysis of decisions made within complex and uncertain professional contexts. David Kolb's experiential learning theory further reinforced the importance of reflection by identifying reflective observation as a key phase in the cycle through which experience is transformed into knowledge. These theoretical contributions have significantly shaped contemporary perspectives on adult education and teacher professional learning.

Recent studies in the fields of andragogy and continuous professional development indicate that effective teacher training should be structured as a reflective and dialogic learning process. Such an approach enables educators to critically reconsider their teaching strategies, identify professional difficulties, and formulate pathways for professional improvement. Accordingly, many professional development programs increasingly incorporate reflection-oriented methods,

such as case analysis, reflective journals, peer dialogue, microteaching sessions, and the examination of video-recorded lessons.

Nevertheless, the effectiveness of these pedagogical tools largely depends on the conditions under which they are implemented. Although scholarly interest in reflective practice has expanded considerably, limited attention has been devoted to the systematic identification of methodological conditions that ensure the coherent and purposeful development of reflective competence within systems of in-service teacher education. A substantial proportion of existing studies focuses primarily on particular reflective techniques or instruments, while the broader organizational, psychological-pedagogical, and didactic conditions necessary for their effective integration into professional development frameworks remain insufficiently explored. This issue becomes especially relevant in countries undergoing systemic transformations in teacher professional development, including Uzbekistan.

Literature Review. Reflection has traditionally been regarded as a fundamental mechanism through which professional experience is transformed into meaningful learning. Early theoretical interpretations characterized reflective thinking as an active and purposeful process of inquiry that begins with a situation of doubt or a problematic experience and proceeds through systematic analysis and reasoning (Dewey, 1933/1998). This conceptualization was further developed in the field of professional education through the distinction between reflection-in-action, referring to thinking that occurs during professional activity, and reflection-on-action, which involves retrospective examination of completed actions. These concepts highlight how practitioners acquire professional knowledge by critically reconsidering their decisions in complex and uncertain contexts (Schön, 1983).

Within the framework of experiential learning theory, reflection is considered a crucial phase connecting concrete experience with conceptual understanding. Through reflective observation, practical experience can be interpreted, generalized, and transformed into professional knowledge (Kolb, 1984). In the context of teacher professional development, these theoretical perspectives collectively support the view that reflective activity should be regarded not as an additional element of training, but as a structural component of sustainable professional growth.

In the domain of teaching English as a foreign language (TESOL/ELT), reflective practice is commonly conceptualized as a multidimensional construct encompassing several interrelated processes: systematic observation of classroom events, interpretative analysis grounded in professional knowledge, and informed decision-making aimed at improving subsequent pedagogical actions (Farrell, 2018). From this standpoint, reflective competence can be defined as the enduring capacity to engage in purposeful reflection across different temporal stages of teaching—before, during, and after instruction—as well as across different professional contexts, including individual practice, collaboration with colleagues, and institutional environments. Importantly, contemporary scholarship increasingly

conceptualizes reflection not solely as an individual cognitive activity but also as a socially mediated process shaped by professional dialogue, feedback mechanisms, and collaborative reflection within communities of practice (Wenger-Trayner & Wenger-Trayner, 2020). This shift from individual introspection toward socially constructed learning corresponds with modern professional development models that prioritize dialogue, mentoring, and collaborative professional communities.

Research in the field of English language teaching identifies a broad spectrum of reflective instruments that support teachers' professional awareness and analytical depth. These tools include reflective journals, analysis of critical incidents, professional portfolios, peer observation, and structured discussion formats (Boud et al., 1985; Farrell, 2018). Nevertheless, recent studies emphasize that the mere presence of reflective tools does not automatically lead to meaningful reflective practice. Teachers may limit their reflections to descriptive accounts rather than analytical interpretation, avoid addressing emotionally challenging aspects of teaching, or fail to translate insights into practical changes in classroom instruction unless supportive pedagogical conditions are established (Mann & Walsh, 2017). As a result, contemporary scholarship increasingly adopts an ecological perspective on teacher reflection, suggesting that reflective competence develops most effectively when reflective tools are embedded within a coherent professional learning environment, supported by facilitative pedagogy and sustained professional interaction.

Another emerging perspective conceptualizes reflection as a temporally extended and forward-looking process. In this interpretation, reflective practice encompasses not only retrospective analysis of teaching but also anticipatory reflection that informs lesson planning and future pedagogical decisions. Empirical investigations into the reflective practices of EFL teachers illustrate how anticipatory reflection may occur both individually and collaboratively, particularly when teachers participate in continuous, inquiry-based dialogue that enables them to reconsider established routines and develop alternative instructional strategies (Burhan-Horasanlı & Ortaçtepe Hart, 2024).

A substantial body of literature in English language teaching further indicates that collaborative forms of professional learning—such as teacher development groups, peer dialogue, and moderated online discussions—can significantly deepen reflective thinking. These collaborative settings enable teachers to consider diverse perspectives, justify pedagogical decisions, and maintain accountability for implementing changes in their practice (Farrell, 2018; Wenger-Trayner & Wenger-Trayner, 2020). Recent empirical studies in ELT contexts provide additional support for this claim.

For instance, a longitudinal qualitative investigation involving in-service EFL teachers in Turkey conducted by Burhan-Horasanlı and Ortaçtepe Hart (2024) examined online discussions, reflective narratives, and teacher interviews. The study demonstrated that reflective practice can simultaneously function at individual,

collaborative, and collective levels when educators participate in sustained dialogic interaction over time. The findings indicate that collaborative reflection not only facilitates the evaluation of past teaching practices but also stimulates prospective pedagogical transformation.

Similarly, research exploring structured reflection cycles among EFL teachers suggests that guiding educators from initial descriptive observation toward deeper interpretative reflection and pedagogical planning can strengthen their engagement in reflective processes and enhance the quality of reflective outcomes (Aslan, 2022). Despite differences in research settings, these studies converge on a shared conclusion relevant to the design of professional development programs: teacher reflection becomes more effective when professional dialogue is supported, norms of trust and openness are cultivated, and reflective activities are sustained rather than sporadic.

Video-based reflection is widely recognized as an effective mechanism that enables teachers to observe classroom interaction more objectively, identify implicit instructional routines, and reconsider their pedagogical decisions. Lorantz et al. (2021) explored how pre-service teachers enhanced their reflective capacities through virtual exchange programs that utilized recorded synchronous sessions as stimuli for post-lesson reflection and subsequent interviews.

Murphy Odo (2023) investigated the perceptions of pre-service English teachers regarding video-based peer feedback and found that participants used this feedback to identify strengths and limitations in their teaching, refine their professional judgment, and broaden their repertoire of pedagogical strategies through observation of their peers' practices.

From the standpoint of andragogical theory, professional education for adults should connect reflective learning to authentic professional needs, encourage learner autonomy, and establish conditions that enable educators to take responsibility for their own professional development trajectories (Mitina, 1998). Empirical evidence supports the view that teachers demonstrate higher levels of engagement in reflective activities when they perceive reflection as a practical tool for addressing real classroom challenges and improving learning outcomes.

Taken together, the reviewed literature indicates that reflective competence in English language teaching develops through the interaction of three interrelated elements: the theoretical framework of reflection, practical reflective tools (such as journals, case analyses, microteaching, and video observation), and facilitating conditions that include organizational support, psychological safety, facilitative pedagogy, and coherent didactic design. Recent empirical research in ELT contexts (Aslan, 2022; Burhan-Horasanlı & Ortaçtepe Hart, 2024; Lorantz et al., 2021; Murphy Odo, 2023) demonstrates that collaborative dialogue and the use of video materials can substantially enrich reflective learning when these practices are systematically organized over time. Nevertheless, many existing studies remain focused on specific tools or isolated contexts

and provide limited systematization of the methodological conditions required to integrate reflection-oriented practices into sustainable professional development frameworks. This limitation substantiates the relevance of the present study, which seeks to identify the organizational, psychological-pedagogical, and didactic conditions necessary for the effective development of reflective competence within teacher professional development systems.

Aim. The purpose of this study is to provide a theoretical substantiation and systematic organization of the methodological prerequisites necessary for strengthening teachers' reflective capacity within the framework of in-service teacher education. In order to achieve this purpose, several intermediate research objectives are addressed: (a) to analyze international theoretical and empirical research devoted to reflective practice in teacher professional development; (b) to conceptualize reflective competence as an integrated professional characteristic of practicing educators; (c) to identify and theoretically substantiate the organizational-pedagogical, psychological-pedagogical, and didactic conditions that promote the effective development of reflective competence; and (d) to structure these conditions within a coherent model applicable to professional development programs designed for English language teachers.

Methodology. The study employs a theoretical research design based on qualitative analytical approaches widely used in pedagogical and educational scholarship. Considering the conceptual orientation of the research, the methodological framework relies on conceptual analysis, comparative analysis, and theoretical modeling rather than on the collection of empirical data. The theoretical foundation of the research draws upon classical and contemporary theories of reflection and professional learning, including frameworks of reflective thinking, experiential learning, adult education (andragogy), and social learning theory. Among the principal theoretical perspectives utilized are the concept of reflective thinking as a mechanism for learning from experience, models of professional reflection occurring during and after action, experiential learning cycles, and socio-constructivist interpretations of professional development. These theoretical positions provide the conceptual basis for interpreting reflective competence as a dynamic and multi-component professional capacity.

At the initial stage of the research, a systematic review of international and national scholarly literature on teacher reflection and reflective competence was conducted. Academic journal articles, monographs, and doctoral dissertations published predominantly in English were examined in order to identify dominant theoretical perspectives, recurring methodological approaches, and existing limitations in the organization of reflective professional development for teachers. Particular attention was given to recent empirical studies within the field of English language teaching that explore collaborative reflection, video-based reflection, coaching practices, and mentoring strategies.

During the second stage, a comparative analysis of existing models and practical approaches to reflective

professional development was undertaken. This analytical procedure made it possible to determine common structural characteristics and enabling factors that influence the effectiveness of reflective approaches within in-service teacher training systems. As a result of this analysis, the methodological conditions facilitating the development of reflective competence were classified into three interrelated categories: organizational-pedagogical, psychological-pedagogical, and didactic conditions. Each of these categories was examined with regard to its functional significance, its role within professional learning environments, and its contribution to the enhancement of teachers' reflective capacity.

At the final stage of the study, theoretical modeling was applied to construct an integrated framework for the implementation of reflective competence development within in-service teacher education programs. The proposed model synthesizes the identified methodological conditions and arranges them within a staged structure that corresponds to the logic of adult learning and professional growth. The resulting framework is intended to provide a conceptual foundation for the design, implementation, and further improvement of reflection-oriented professional development courses for English language teachers.

Results. Based on a theoretical and comparative examination of international and national studies devoted to teacher reflection and professional learning, the study identified and systematized a set of methodological conditions that support the effective development of reflective competence among in-service teachers. These conditions were classified into three interrelated categories: organizational-pedagogical, psychological-pedagogical, and didactic conditions. Such classification corresponds to the principles of adult professional learning and is consistent with contemporary interpretations of reflective practice in teacher education (Schön, 1983; Farrell, 2018; Wenger-Trayner & Wenger-Trayner, 2020).

The organizational-pedagogical conditions refer to the structural and institutional framework that enables reflective learning within professional development programs. These include the creation of a reflection-oriented learning environment in teacher training courses, the transformation of the trainer's role from a transmitter of knowledge to a facilitator of reflective dialogue, and the provision of institutional support for reflective learning both during and after training. Previous studies indicate that reflective practice becomes sustainable when it is embedded in coherent program design, supported by allocated time for reflective activity, and recognized by institutional leadership as a core professional value (Kolb, 1984; Burhan-Horasanlı & Ortaçtepe Hart, 2024).

Psychological-pedagogical conditions relate to teachers' internal readiness for reflection and the interpersonal climate within professional learning settings. These conditions include the development of reflective dispositions, psychological safety, mutual trust, and open communication among course participants. Research on adult education and teacher professional learning demonstrates that educators engage more deeply in reflection when they perceive it as relevant

for addressing authentic professional challenges and when reflective dialogue occurs within a supportive, non-judgmental environment (Mitina, 1998; Mann & Walsh, 2017; Farrell, 2018).

Didactic conditions involve the deliberate selection and systematic implementation of instructional strategies, methods, and learning tools that stimulate reflective thinking. Such strategies include pedagogical case analysis, reflective journals, microteaching sessions, video-based lesson analysis, peer feedback, and coaching practices. Empirical research in English language teaching indicates that these approaches significantly strengthen reflective awareness when applied in a structured and continuous manner with clear analytical guidance rather than being used occasionally or in isolation (Aslan, 2022; Loranc et al., 2021; Murphy Odo, 2023).

Taking these methodological conditions into account, the study developed an integrated theoretical model for fostering reflective competence within in-service teacher training. Within this model, reflective competence is conceptualized as a dynamic and multifaceted professional capacity that develops through continuous interaction between experience, reflection, dialogue, and professional action. The model is grounded in theories of experiential and reflective learning, which describe professional learning as a cyclical process involving experience, analysis, conceptualization, and transformation of practice (Dewey, 1933/1998; Kolb, 1984; Schön, 1983).

The proposed framework integrates the three groups of methodological conditions into a unified system and operationalizes them through a phased structure of professional learning. This structure ensures coherence between theoretical principles and practical implementation. Although each group of conditions performs a specific function, together they constitute a comprehensive framework that supports the systematic development of reflective competence. The theoretical modeling process led to the identification of three successive stages of reflective competence development within in-service teacher education programs: preparatory, main, and reflective-evaluative stages.

The preparatory stage establishes the organizational and psychological foundation necessary for reflective learning. At this stage, teachers' initial reflective dispositions are assessed, training content is designed to include reflective components, and trainers prepare to facilitate reflective dialogue. Research in adult education suggests that clear explanation of objectives, expectations, and professional relevance at the beginning of training increases teachers' engagement in reflective activities and strengthens motivation for professional self-development (Mitina, 1998; Farrell, 2018).

The main stage constitutes the central phase of reflective development. During this stage, teachers participate in structured reflective activities integrated into professional learning modules. These activities include analysis of pedagogical cases, reflective seminars, microteaching practice, collaborative dialogue, and video-based lesson analysis. Empirical research in English language teaching shows that reflection becomes

deeper when teachers analyze their own instructional artifacts and engage in structured discussions with colleagues and facilitators, which allows them to articulate assumptions, evaluate pedagogical decisions, and consider alternative instructional strategies (Loranc et al., 2021; Burhan-Horasanlı & Ortaçtepe Hart, 2024).

The reflective-evaluative stage focuses on consolidating reflective experiences and integrating reflective practices into teachers' ongoing professional activity. At this stage, educators evaluate their professional development, reflect on changes in their instructional approaches, and formulate further professional learning goals. Reflective journals, self-assessment instruments, and peer feedback mechanisms are used to support the continued application of reflective skills beyond the training context. Research demonstrates that post-training reflection contributes to the sustainability of professional learning and supports the development of a reflective professional identity (Murphy Odo, 2023; Wenger-Trayner & Wenger-Trayner, 2020).

The main theoretical outcome of the study lies in conceptualizing reflective competence development as a sequential and condition-dependent process embedded within in-service teacher training. The proposed model demonstrates that reflection-oriented pedagogical methods become most effective when supported simultaneously by organizational structures, psychological readiness, and coherent didactic design. By integrating theoretical foundations with contemporary empirical findings in English language teaching, the study provides a structured framework suitable for designing and improving reflection-oriented professional development programs.

Discussion. The analysis conducted in this study demonstrates that reflective competence within teacher professional development cannot be reduced to the isolated use of reflective techniques or occasional reflective exercises. Instead, reflective competence emerges as a complex process shaped by the broader contexts in which educators learn, collaborate, and interpret their professional experiences. Accordingly, the proposed model shifts analytical attention from individual reflection tools toward the learning environment that enables their meaningful use.

This orientation corresponds with contemporary perspectives that conceptualize reflection as a socially situated practice rather than merely an internal cognitive activity. Research in English language teaching and teacher professional development consistently indicates that reflective processes become deeper and more sustainable when they are embedded within institutional practices and supported through dialogue, collaborative inquiry, and shared meaning-making within professional communities (Farrell, 2018; Wenger-Trayner & Wenger-Trayner, 2020). The model developed in this study aligns with these perspectives by demonstrating how organizational, psychological, and didactic factors interact to sustain reflective professional learning over time.

Organizational-pedagogical conditions play a particularly important role in shaping reflective learning environments. Previous studies have emphasized the influence of program design, institutional leadership,

and trainers' professional attitudes on the outcomes of teacher professional development. The findings of the present study suggest that reflective competence develops most effectively when trainers act as facilitators of inquiry rather than as traditional transmitters of knowledge. Such an approach corresponds with Schön's (1983) interpretation of professional learning as a dialogic process of exploration and discovery and also supports Kolb's (1984) view that reflection becomes meaningful when embedded within structured experiential learning environments. Without such institutional support, reflective practices risk becoming inconsistent or remaining at a superficial descriptive level.

Equally important are the psychological-pedagogical factors that shape teachers' willingness to engage in reflective processes. Motivation, trust, and psychological safety determine whether teachers perceive reflection as a meaningful professional tool or as an externally imposed requirement. Adult educators are more inclined to participate in reflective dialogue when the process is directly connected to their current professional needs and when the learning environment encourages openness rather than evaluation (Mitina, 1998). Studies in English language teaching further indicate that reflective discussions become more analytical and self-critical when educators are able to express uncertainty, doubts, or unsuccessful experiences without fear of negative judgment (Farrell, 2018; Mann & Walsh, 2017). These findings confirm that reflective competence cannot be developed solely through formal instructional requirements.

Recent empirical research also supports the didactic dimension of the proposed model. Studies examining video-based reflection, peer feedback, and collaborative lesson analysis in English language teaching demonstrate that reflection becomes more effective when teachers engage with concrete representations of their own classroom practice and receive structured analytical guidance (Aslan, 2022; Loranc et al., 2021; Murphy Odo, 2023). The innovative aspect of the proposed model lies not in introducing new reflection tools but in integrating existing tools into a coherent and systematically organized learning process. By sequencing reflective activities and linking them across stages of professional development, the model addresses a limitation frequently observed in earlier studies, where reflection methods were implemented separately and without coordination.

The staged structure of the model, including preparatory, main, and reflective-evaluative phases, also introduces an important temporal dimension to the organization of reflective learning. This structure reflects the cyclical logic of experiential learning, in which experience is continuously reconsidered, reinterpreted, and transformed through reflective processes, as described in Kolb's (1984) learning cycle. Furthermore, the model corresponds with contemporary research in English language teaching that highlights reflection-for-action and collaborative inquiry as key mechanisms for pedagogical innovation (Burhan-Horasanlı & Ortaçtepe Hart, 2024).

By incorporating diagnostic and consolidation stages, the model also strengthens the sustainability of reflective practice beyond the training environment. The study thus contributes to the theoretical understanding of reflective competence development among teachers by proposing a structured conceptual framework that can guide both the design and evaluation of professional development programs for English language educators.

The relevance of this framework becomes particularly evident in rapidly evolving educational systems. In Uzbekistan, teachers are currently confronted with simultaneous transformations, including curriculum reform, digitalization of education, and the introduction of new pedagogical standards. Within such contexts, reflective competence functions as a crucial professional capacity that enables teachers to interpret educational changes, adapt their teaching strategies, and maintain continuous professional learning. Consequently, the proposed model contributes both to the scholarly discussion of reflective practice and to the broader objective of strengthening the effectiveness and sustainability of teacher professional development systems.

CONCLUSION. The present study has provided a theoretical substantiation of a system of methodological conditions aimed at fostering the development of teachers' reflective competence within in-service teacher education. By interpreting reflective competence as a phased and condition-dependent process, the research moves beyond approaches that focus narrowly on individual reflection tools. Instead, it proposes a comprehensive conceptual framework in which organizational arrangements, psychological readiness, and didactic structuring are integrated into a unified model of professional development.

The principal theoretical contribution of the study lies in the systematic organization of reflective competence development through the interaction of three mutually connected groups of conditions: organizational-pedagogical, psychological-pedagogical, and didactic. Unlike approaches that treat reflective activities as isolated techniques, the proposed framework demonstrates that reflection-oriented strategies achieve meaningful results only when they operate within a supportive institutional environment, are guided by dialogic pedagogical practices, and are embedded within a coherent instructional design. The introduction of a staged developmental structure—comprising preparatory, main, and reflective-evaluative phases—also strengthens the theoretical explanation of reflective competence formation by aligning it with the temporal logic of adult professional learning.

From a practical perspective, the findings offer a conceptual basis for the improvement and modernization of in-service teacher training programs, particularly those designed for English language educators. The suggested model may assist professional development centers, teacher education institutions, and program designers in structuring reflection-oriented learning activities, selecting appropriate pedagogical methods, and clarifying the facilitator's role in supporting teachers' professional inquiry. Incorporating reflective

practices—such as case analysis, video-based reflection, microteaching sessions, and peer dialogue—within a systematically organized program not only strengthens teachers' awareness of their professional actions but also encourages the pursuit of autonomous professional growth.

The outcomes of the research also carry implications for educational leadership and policy development. When educational authorities and school administrators recognize reflective competence as a central dimension of teacher professionalism, reflective practices can extend beyond formal training courses and become embedded in everyday professional culture. Such support may take the form of professional learning communities, mentoring systems, and continuous coaching initiatives. Institutions that encourage these forms of collaborative learning contribute to the sustainability of reflective development and promote a culture of continuous professional improvement.

Although the present research is primarily theoretical in nature, it outlines several directions for further scholarly inquiry. Future empirical investigations may focus on testing the proposed model within diverse educational contexts, examining how teachers' reflective competence evolves over extended periods, and exploring potential relationships between teachers' reflective abilities and student learning outcomes. Longitudinal studies and mixed-method research designs could provide deeper insights into how the identified methodological conditions function in practice and how they can be adapted to different professional development environments.

Overall, the proposed theoretical model advances the academic discussion of reflective practice in teacher education while offering practical guidance for enhancing the effectiveness and sustainability of in-service teacher training. By positioning reflective competence as a fundamental objective of professional development and by identifying the conditions necessary for its systematic formation, the study contributes to addressing contemporary educational challenges and supports the preparation of teachers who are capable of acting as reflective and proactive agents of professional transformation.

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TEACHING PROFESSIONAL ENGLISH COMMUNICATION THROUGH A METACOGNITIVE APPROACH IN THE CONTEXT OF INTERNATIONAL ACADEMIC MOBILITY (THE CASE OF LOGISTICS)

Abstract.

The intensification of international academic mobility has transformed professional English communication from a supplementary skill into a core professional competence for students of logistics. However, traditional instruction in English for Specific Purposes (ESP) frequently emphasises terminological accuracy at the expense of learners' capacity to plan, monitor, and evaluate their own communicative performance in unpredictable intercultural professional settings. This article investigates the effectiveness of a metacognitive approach to teaching professional English communication to undergraduate logistics students preparing for international academic mobility programmes. A quasi-experimental pre-test/post-test design with experimental ($n=58$) and control ($n=56$) groups was implemented over one academic semester at higher education institutions of the Republic of Uzbekistan. The experimental intervention integrated metacognitive strategy instruction – planning, monitoring, evaluation, and self-regulation – into a task-based ESP syllabus built on authentic logistics communication scenarios (freight negotiation, customs documentation discourse, supply chain incident reporting, and academic exchange interaction). Data were collected through a professional communicative competence test, the Metacognitive Awareness of Communication Strategies Inventory (MACSI), and structured observation of simulated professional interactions. Results demonstrated statistically significant gains in the experimental group across all measured components ($t=6.42$; $p<0.001$; Cohen's $d=0.84$), with the strongest growth in discourse-strategic and self-regulatory dimensions. The findings confirm that explicit metacognitive scaffolding substantially accelerates the development of professional English communication and enhances learners' readiness for international academic mobility. Pedagogical implications for ESP syllabus design in logistics education are discussed.

Keywords: metacognitive approach; professional English communication; English for Specific Purposes (ESP); international academic mobility; logistics education; self-regulated learning; communicative competence; strategy instruction.

1. Introduction

The globalisation of higher education and the expansion of international academic mobility programmes – Erasmus+, DAAD, Mevlana, and inter-university exchange agreements across Central Asia and Europe – have fundamentally redefined the requirements imposed on graduates of non-philological specialities. For students of logistics, a field whose professional environment is inherently transnational, the ability to communicate in professional English is no longer an optional advantage but a precondition for full participation in academic exchange, internship placements at international freight-forwarding companies, and subsequent employment within global supply chains.

At the same time, empirical observations and diagnostic testing in Uzbek higher education institutions reveal a persistent gap between the terminological knowledge that students acquire through conventional ESP courses and their actual capacity to deploy that knowledge in real communicative events: negotiating delivery terms with a foreign counterpart, clarifying discrepancies in a bill of lading, participating in a seminar discussion at a host university, or reporting a supply chain disruption to an international team. Students frequently possess the lexis of Incoterms, customs procedures, and warehouse operations, yet fail to manage the interaction itself – they do not plan their communi-

cative moves, do not monitor comprehension breakdowns, and do not evaluate or repair their own performance.

This deficit points not to a lack of linguistic input but to underdeveloped metacognition – the learner's knowledge about and regulation of their own cognitive and communicative processes. Since Flavell's foundational formulation of metacognition as "cognition about cognition" and its subsequent operationalisation in language pedagogy by O'Malley and Chamot, Oxford, Wenden, and Anderson, a substantial body of research has demonstrated that learners who consciously plan, monitor, and evaluate their language use outperform peers of comparable proficiency. Vandergrift and Goh's metacognitive pedagogical cycle for listening, and later extensions to speaking and interactional competence, provide a tested instructional architecture. However, the application of metacognitive strategy instruction to professional communication in logistics, and specifically within the preparatory context of international academic mobility, remains under-researched: existing ESP studies in the logistics domain concentrate predominantly on terminology, genre analysis of transport documentation, and needs analysis, while the self-regulatory dimension of professional discourse has received only fragmentary attention.

The purpose of the present study is therefore to develop, implement, and experimentally verify a methodology for teaching professional English communication to logistics students on the basis of a metacognitive approach, oriented towards the demands of international academic mobility. The study addresses three research questions: (1) To what extent does explicit metacognitive strategy instruction improve the professional English communicative competence of logistics students compared with conventional ESP instruction? (2) Which components of professional communicative competence – linguistic, discourse-strategic, sociocultural, and self-regulatory – are most sensitive to metacognitive intervention? (3) How does metacognitive awareness of communication strategies correlate with performance in simulated professional interaction?

2. Materials and Methods

The study employed a quasi-experimental pre-test/post-test design with non-equivalent groups, conducted during one academic semester (15 teaching weeks, 60 contact hours) at higher education institutions of the Republic of Uzbekistan offering the bachelor's programme in Logistics. The sample comprised 114 second- and third-year undergraduate students (aged 19–22), all of whom had declared an intention to participate in international academic mobility programmes or international internships. Participants were assigned to an experimental group (EG, $n=58$) and a control group (CG, $n=56$). Baseline equivalence was verified by an entry proficiency test aligned with CEFR descriptors; both groups clustered at the B1–B1+ range with no statistically significant difference ($t=0.61$; $p=0.54$).

The control group followed the standard ESP syllabus for logistics students, based on terminological work, reading of professional texts, translation exercises, and reproductive dialogue practice. The experimental group followed the same thematic content but delivered through a metacognitively structured task-

based methodology comprising four recursive phases: (1) forethought and planning – goal-setting, prediction of communicative obstacles, and selection of strategies prior to each professional communication task; (2) performance and monitoring – execution of the task (simulated freight negotiation, customs documentation discourse, incident reporting, academic seminar interaction) with embedded self-monitoring prompts; (3) evaluation – guided self- and peer-assessment against analytic descriptors; and (4) self-regulation and transfer – reflective journaling, strategy re-selection, and transfer of strategies to new scenarios. The instructional content of the experimental course was organised around four professional-communicative modules directly modelling the target situations of academic mobility, as presented in Table 1.

Three instruments were used for data collection. First, a Professional Communicative Competence Test (PCCT) developed by the author and validated by expert judgement (content validity index CVI=0.89) measured four components: linguistic (professional lexis and grammar in context), discourse-strategic (turn management, negotiation moves, repair), sociocultural (register, politeness, intercultural appropriateness), and self-regulatory (planning and self-correction behaviour, assessed through task-based performance). Second, the Metacognitive Awareness of Communication Strategies Inventory (MACSI), a 30-item five-point Likert questionnaire adapted from Vandergrift et al.'s MALQ and O'Malley–Chamot's taxonomy, measured metacognitive awareness (internal consistency in the present sample: Cronbach's $\alpha=0.86$). Third, structured observation of simulated professional interactions was conducted by two independent raters using an analytic rubric (inter-rater reliability: Cohen's $\kappa=0.81$). Quantitative data were processed in SPSS 26.0 using paired and independent samples t-tests, with effect sizes calculated as Cohen's d ; the significance threshold was set at $p<0.05$.

Table 1.

Metacognitive-communicative modules of the experimental ESP course for logistics students

No.	Module (target mobility situation)	Core professional communication tasks	Focal metacognitive strategies
1	Freight and transport negotiation	Negotiating delivery terms (Incoterms 2020), price and liability discussion with foreign partners	Goal-setting; predicting counterpart moves; planned use of clarification and hedging
2	Customs and transport documentation discourse	Clarifying discrepancies in bills of lading, CMR notes, customs declarations; formal e-mail exchange	Comprehension monitoring; selective attention to critical data; self-verification
3	Supply chain incident reporting	Oral and written reporting of delays, damage and force majeure to an international team	Directed attention; monitoring accuracy under time pressure; post-task evaluation
4	Academic mobility interaction	Seminar discussion, academic presentation, consultation with host-university supervisors	Planning of discourse structure; real-time self-monitoring; reflective self-assessment and strategy transfer

3. Results

Analysis of the pre-test data confirmed the initial comparability of the groups across all four components

of professional communicative competence and metacognitive awareness (all $p>0.05$). Post-test results, by

contrast, revealed a systematic and statistically significant advantage of the experimental group. Table 2 summarises the dynamics of the mean scores (expressed as

percentages of the maximum attainable score) for both groups.

Table 2.

Pre-test and post-test results by components of professional communicative competence (mean, % of maximum score)

Component	EG pre	EG post	CG pre	CG post	ΔEG–ΔCG
Linguistic (professional lexis and grammar)	58.4	79.6	57.9	68.3	+10.8
Discourse-strategic (negotiation, repair, turn management)	49.2	74.8	48.7	58.1	+16.2
Sociocultural (register, intercultural appropriateness)	51.6	72.4	52.0	60.9	+11.9
Self-regulatory (planning, monitoring, self-correction)	44.8	73.5	45.3	54.2	+19.8
Overall professional communicative competence	51.0	75.1	51.0	60.4	+14.7

As Table 2 shows, both groups improved over the semester, which is expected given continued ESP instruction; however, the magnitude of growth differed sharply. The experimental group gained on average 24.1 percentage points against 9.4 in the control group. The largest between-group differences emerged precisely in the two components targeted by the intervention: the self-regulatory component (+19.8 percentage

points net advantage) and the discourse-strategic component (+16.2), confirming that metacognitive scaffolding acts most strongly on the procedural, interaction-management dimension of professional communication rather than merely on declarative linguistic knowledge. Inferential statistics for the post-test comparison are presented in Table 3.

Table 3.

Independent samples t-test results for post-test scores (EG vs CG)

Measure	t-value	df	p-value	Cohen's d
Overall PCCT score	6.42	112	<0.001	0.84
Discourse-strategic component	5.87	112	<0.001	0.79
Self-regulatory component	6.95	112	<0.001	0.91
MACSI (metacognitive awareness)	7.13	112	<0.001	0.95
Simulated interaction rating (rubric)	5.34	112	<0.001	0.72

All differences are statistically significant at $p < 0.001$ with large effect sizes ($d = 0.72$ – 0.95). Metacognitive awareness measured by MACSI rose in the experimental group from a mean of 3.02 to 4.11 on the five-point scale, while the control group showed only marginal, non-significant movement (3.05 to 3.21; $p = 0.09$). A strong positive correlation was found between post-test MACSI scores and rated performance in simulated professional interaction (Pearson's $r = 0.68$; $p < 0.001$), indicating that learners who reported higher planning, monitoring, and evaluation behaviour also performed more effectively in negotiation, documentation discourse, and academic interaction tasks. Qualitative observation data corroborated the quantitative pattern: experimental-group students initiated repair sequences 2.6 times more frequently, used pre-planned discourse frames in negotiations, and demonstrated visibly reduced communication avoidance in unpredictable turns of the simulation.

4. Discussion

The findings provide convergent evidence for the first research question: explicit metacognitive strategy instruction embedded in a task-based ESP syllabus produces significantly greater growth in professional English communicative competence than content-equivalent conventional instruction. This result is consistent with the broader literature on strategy-based instruction and self-regulated language learning, and extends it in two directions. First, it demonstrates the transferability of the metacognitive pedagogical cycle – originally elaborated for listening comprehension – to interactive professional discourse in a technical domain (logistics), where communication is characterised by high informational density, procedural constraints (documentation, regulations, Incoterms), and elevated cost of misunderstanding. Second, it situates metacognitive instruction within the preparatory logic of international academic mobility, where learners must function autonomously in a foreign academic and professional en-

vironment without the immediate support of an instructor; the self-regulatory apparatus developed during the course is precisely the mechanism that sustains continued learning abroad.

Regarding the second research question, the differential sensitivity of competence components is theoretically meaningful. The linguistic component improved substantially in both groups, since terminological and grammatical content was identical; the decisive between-group gap arose in the discourse-strategic and self-regulatory components. This supports the interpretation that the bottleneck in professional communication for B1-level logistics students is not primarily lexical but procedural: what learners lack is an executive layer that orchestrates existing linguistic resources under real-time interactional pressure. Metacognitive instruction supplies exactly this layer. The strong MACSI-performance correlation addressing the third research question further suggests that metacognitive awareness is not epiphenomenal self-report but a functional predictor of communicative behaviour, which aligns with Vandergrift and Goh's findings and with Anderson's model of metacognition as the driver of skill orchestration.

Certain limitations must be acknowledged. The quasi-experimental design without full randomisation constrains causal inference; the semester-long duration does not capture long-term retention or actual performance during subsequent mobility periods; and self-report instruments, despite acceptable reliability, are subject to response bias. Future research should trace experimental-group participants into their mobility placements to examine ecological transfer, extend the model to other transport-economic specialities, and investigate the integration of digital tools – intelligent tutoring systems and AI-mediated simulation environments – as amplifiers of metacognitive feedback loops.

5. Conclusion

The study developed and experimentally validated a methodology for teaching professional English communication to logistics students on the basis of a metacognitive approach oriented towards international academic mobility. The methodology, organised around four professional-communicative modules and a recursive cycle of planning, monitoring, evaluation, and self-regulation, produced statistically significant and practically large improvements in professional communicative competence ($t=6.42$; $p<0.001$; $d=0.84$), with the greatest gains in discourse-strategic and self-regulatory dimensions. The results warrant three conclusions. First, metacognitive strategy instruction should be recognised as a structural principle of ESP syllabus design for logistics education, not an optional supplement. Second, preparation for academic mobility is most effective when it targets the learner's executive control over communication rather than terminological coverage alone, because it is this control that enables autonomous functioning in the host environment. Third, the demonstrated correlation between metacognitive awareness and interactional performance justifies the

inclusion of metacognitive diagnostics (such as MACSI) in the selection and preparation procedures of mobility programmes. The proposed model is recommended for implementation in ESP courses of transport, logistics, and international trade programmes of higher education institutions.

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TEACHING THE SUBJECT “TARBIYA” (MORAL EDUCATION) IN PRIMARY GRADES ON THE BASIS OF THE INTEGRATION OF STEAM AND JAPANESE EDUCATIONAL APPROACHES

Abstract.

The subject “Tarbiya” (moral education), introduced into the curriculum of general secondary schools of the Republic of Uzbekistan, is intended to form pupils’ moral consciousness, social responsibility, and national and universal values from the earliest years of schooling. In practice, however, the teaching of Tarbiya in primary grades frequently remains verbal and declarative: values are explained rather than lived, and moral knowledge is not transformed into moral behaviour. This article substantiates and experimentally verifies a model for teaching Tarbiya in primary grades based on the integration of two complementary pedagogical systems: the STEAM approach (Science, Technology, Engineering, Arts, Mathematics), which supplies activity-based, project-oriented, and creative mechanisms of learning, and Japanese educational practice – in particular tokkatsu (special class activities), dōtoku (moral education as reflection on lived experience), o-sōji (collective cleaning), and kyūshoku (shared meal duty) – which supplies mechanisms for converting values into daily habitual action. A quasi-experimental study was conducted during one academic year in primary grades (Grades 2–3) with experimental ($n=112$) and control ($n=108$) cohorts. Data were collected through a moral judgement and behaviour diagnostic complex, structured observation of pupils’ cooperative behaviour, and teacher and parent questionnaires. The experimental cohort demonstrated statistically significant advantages in moral judgement maturity, cooperative behaviour, responsibility for the shared environment, and creative engagement ($t=5.78$; $p<0.001$; Cohen’s $d=0.78$). The study concludes that the STEAM–Japanese integration converts Tarbiya from a subject about values into a practice of values, and proposes a module structure and lesson typology suitable for implementation within the national curriculum.

Keywords: Tarbiya; moral education; primary school; STEAM education; Japanese education; tokkatsu; dōtoku; whole-child education; value-based learning; project activity.

1. Introduction

Modern reform of school education in the Republic of Uzbekistan assigns a special role to the subject “Tarbiya”, which consolidates the moral, civic, ecological, aesthetic, and labour components of upbringing into a single curricular line beginning in the first grade. The normative documents governing the subject emphasise the formation of national identity, respect for elders, honesty, diligence, responsibility, and love for the Motherland alongside universal human values. The strategic importance of this subject is difficult to overestimate: primary school age (7–10 years) is the sensitive period in which moral habits, emotional attitudes towards work and community, and the foundations of character are laid.

Nevertheless, analysis of teaching practice reveals a systemic contradiction. Tarbiya lessons in primary grades are still predominantly delivered through explanation, reading of didactic texts, and reproduction of moral rules – a knowledge-transmission model that develops what pupils can say about values rather than what they habitually do. Psychological research from Kohlberg and Piaget to contemporary character education studies converges on the conclusion that moral development is driven by participation, cooperation, and reflection on lived experience, not by verbal instruction alone. Consequently, a methodological search is required for instruments that embed values in activity.

Two internationally validated resources present themselves for this purpose. The first is the STEAM approach, which extends STEM with the Arts and rests on integrated, project-based, hands-on learning. Although STEAM is usually discussed in relation to cognitive

outcomes, its collaborative project format is intrinsically saturated with educational (tarbiyaviy) potential: distribution of roles, shared responsibility for a product, perseverance in the face of failure, aesthetic care for the result, and ecological reasoning. The second resource is the Japanese model of primary education, internationally recognised for its “whole-child” orientation. Its key institutions – tokkatsu (tokubetsu katsudō, special activities: class meetings, school events, pupil committees), dōtoku (moral education organised as discussion of real dilemmas rather than moralising), o-sōji (daily collective cleaning of the classroom and school by pupils themselves), kyūshoku tōban (rotating duty for serving the shared school meal), and han (small mixed-ability groups) – constitute a technology for transforming values into stable daily habits. Comparative studies note that it is precisely this non-cognitive infrastructure that underlies Japanese pupils’ discipline, cooperativeness, and sense of communal responsibility.

The scientific novelty of the present study lies in the pedagogically substantiated integration of these two systems within the subject Tarbiya: STEAM supplies the content-activity core of the lesson (an integrated value-oriented project), while Japanese practice supplies the organisational-behavioural shell (routines, duties, reflection circles) that carries the value beyond the lesson into daily school life. The study addresses three research questions: (1) What model of integrating STEAM and Japanese educational practice is adequate to the aims and conditions of the subject Tarbiya in primary grades of Uzbekistan? (2) Does the integrated model produce measurable advantages in pupils’ moral

judgement and moral behaviour compared with conventional instruction? (3) How do teachers and parents evaluate the applicability of the model within the national curriculum?

2. Materials and Methods

The study was conducted during one academic year (34 teaching weeks) in Grades 2–3 of general secondary schools of the Namangan region. The sample comprised 220 pupils aged 8–10: an experimental cohort (EG, $n=112$, five classes) and a control cohort (CG, $n=108$, five classes), together with 10 primary school teachers and 180 parents participating in the survey component. Baseline equivalence of the cohorts in moral judgement and behavioural indicators was confirmed at entry (all $p>0.05$). The control cohort studied Tarbiya according to the standard curriculum and textbook. The experimental cohort studied the same thematic content through the integrated STEAM–Japanese model.

The integrated model was structured in three layers. The first layer – the value-oriented STEAM project – reorganised each thematic unit of Tarbiya into a two-to three-lesson mini-project in which the moral theme was materialised in a collective product: for example, the theme “Care for nature” became an engineering-art project of designing bird feeders from recycled materials with mathematical measurement and observation journals; the theme “Respect for labour” became a technology project of modelling the professions of the mahalla; the theme “Honesty and justice” incorporated a data project in which pupils gathered and visualised

class agreements. The second layer – Japanese organisational routines adapted to national conditions – introduced han small groups with rotating roles, a weekly class meeting (adaptation of tokkatsu) at which pupils themselves discussed class life and made decisions, collective care for the classroom (adaptation of o-sōji) framed through the national value of poklik (cleanliness/purity), and duty rotations connected to hashar traditions. The third layer – dōtoku-type reflection – replaced moralising summaries with structured discussion circles around real situations that had arisen during the projects and routines, following the Japanese principle of “considering the feelings of others through one’s own experience”. Table 1 presents the module structure of the experimental course.

The diagnostic complex included: (1) a Moral Judgement Test for primary pupils based on adapted dilemma vignettes (12 items; expert content validity CVI=0.87), scored on a three-level maturity scale; (2) a Structured Observation Protocol of cooperative and responsible behaviour (8 indicators: helping, sharing, duty performance, care for shared property, conflict resolution, initiative, perseverance, aesthetic care), completed by two observers per class (inter-rater reliability Cohen’s $\kappa=0.79$); (3) teacher and parent questionnaires on behavioural transfer to home and out-of-lesson contexts (Cronbach’s $\alpha=0.84$); and (4) analysis of project products by aesthetic and cooperative criteria. Quantitative data were processed in SPSS 26.0 using independent and paired samples t-tests with Cohen’s d effect sizes; the significance threshold was $p<0.05$.

Table 1.

Module structure of the integrated STEAM–Japanese model of the subject Tarbiya (Grades 2–3)

Tarbiya value theme	STEAM project core	Japanese practice component	Expected behavioural outcome
Care for nature and ecology	Bird feeder / school garden engineering project with measurement and observation journal	O-sōji: collective care for classroom and school territory	Habitual ecological responsibility
Respect for labour and professions	Modelling mahalla professions; simple mechanisms (technology + art)	Kyūshoku-type duty rotations; han group roles	Voluntary duty performance, respect for work
Honesty, justice, agreement	Class data project: gathering and visualising class rules and choices	Tokkatsu class meeting with pupil-led decisions	Rule-following by conviction, fair conflict resolution
Friendship and cooperation	Collaborative art-construction projects with shared product	Han mixed small groups with rotating leadership	Helping and sharing behaviour
National values and beauty	Ornament geometry project: mathematics of Uzbek patterns (art + maths)	Dōtoku-type reflection circles on experience	Aesthetic care, pride in heritage
Health and self-discipline	Daily routine engineering: designing personal schedules and measuring habits	Morning circle rituals; perseverance norms	Self-regulated daily habits

3. Results

At the end of the academic year, the experimental cohort significantly outperformed the control cohort on

all diagnostic dimensions. Table 2 presents the dynamics of the principal indicators, expressed as the percentage of pupils reaching the high level of each indicator.

Table 2.

Dynamics of moral development indicators: share of pupils at the high level (%)

Indicator	EG pre	EG post	CG pre	CG post
Maturity of moral judgement (dilemma test)	21.4	58.9	22.2	35.2
Cooperative behaviour (observation)	25.0	64.3	24.1	38.0
Responsibility for shared environment	17.9	61.6	18.5	31.5
Duty performance without reminder	23.2	66.1	23.1	36.1
Creative engagement in value-oriented tasks	28.6	69.6	27.8	41.7
Behavioural transfer to home (parent survey)	19.6	52.7	20.4	29.6

The growth of the experimental cohort ranged from 33.1 to 43.7 percentage points against 11.7 to 15.0 in the control cohort. The most pronounced between-group differences arose in behavioural rather than verbal indicators: responsibility for the shared environment (+30.1 percentage points net advantage) and duty performance without external reminder (+29.9), i.e. precisely in the zone served by the Japanese routine

layer of the model. Moral judgement maturity – the cognitive dimension – also grew significantly faster in the experimental cohort (+24.5 net), which is attributable to the dōtoku-type reflection circles, where pupils analysed situations they had actually lived through in their projects and duties. Inferential statistics are summarised in Table 3.

Table 3.

Independent samples t-test results for post-test comparison (EG vs CG)

Measure	t-value	df	p-value	Cohen's d
Composite moral development index	5.78	218	<0.001	0.78
Moral judgement test	5.12	218	<0.001	0.69
Observed cooperative behaviour	6.31	218	<0.001	0.85
Responsibility / duty indicators	6.64	218	<0.001	0.90
Behavioural transfer (parent survey)	4.87	218	<0.001	0.66

All post-test differences are significant at $p < 0.001$ with medium-to-large effect sizes ($d = 0.66$ – 0.90). The teacher survey showed that 9 of 10 experimental-class teachers assessed the model as implementable within the standard timetable without additional hours, noting that the STEAM projects absorbed content simultaneously from Tarbiya, technology, natural science, and mathematics lessons, thereby producing an integrative economy of teaching time. Parents of experimental-class pupils reported statistically more frequent voluntary participation of children in household duties and care for younger siblings (52.7% against 29.6% in the control cohort). Qualitative observation additionally recorded a reduction of teacher disciplinary interventions in experimental classes by approximately one third by the final quarter, coinciding with the consolidation of pupil-led class meeting decisions.

4. Discussion

The findings answer the central research question affirmatively: the integration of STEAM and Japanese educational practice produces significantly greater moral-developmental outcomes in the subject Tarbiya than conventional instruction of identical thematic content. The theoretical interpretation of this result rests on the complementarity of the two integrated systems.

STEAM resolves the motivational and activity deficit of traditional value education: a value ceases to be an object of verbal assimilation and becomes a regulator of real joint activity with a visible product. Japanese practice resolves the transfer deficit: routines such as collective cleaning, duty rotation, and pupil-led meetings extend the value beyond the lesson into the fabric of daily school life, where, according to habit-formation research, repeated contextualised action is the principal mechanism of character consolidation. The observed pattern – maximum experimental advantage precisely in behavioural indicators – is direct empirical evidence of this division of labour between the two layers of the model.

The results are consonant with international findings. Research on tokkatsu and the “Japanese model of holistic education” has repeatedly linked non-cognitive routines to pupils’ social responsibility; the present study demonstrates that these mechanisms remain effective when transposed into the Uzbek cultural context – indeed, their adaptation proved organic, since o-sōji resonates with the national value of poklik, duty rotation with hashar traditions, and the class meeting with the consultative culture of the mahalla. This cultural

congruence is, we argue, a necessary condition of successful borrowing: the model does not import Japanese content but Japanese organisational form, filled with national value content prescribed by the Tarbiya curriculum. Similarly, the STEAM layer confirms character education research indicating that cooperative project work is among the strongest school-based predictors of prosocial behaviour.

Limitations of the study include the quasi-experimental design without full randomisation, the regional character of the sample, the one-year horizon that leaves long-term character consolidation unmeasured, and the partial reliance of behavioural transfer data on parent report. Future research should examine longitudinal retention into the middle grades, the scalability of teacher preparation for the model, and the differentiated contribution of each layer (STEAM core versus routine shell) through component analysis designs.

5. Conclusion

The study developed and experimentally verified a model for teaching the subject Tarbiya in primary grades based on the integration of the STEAM approach and Japanese educational practice. The model comprises three layers – a value-oriented STEAM project core, an adapted layer of Japanese organisational routines (tokkatsu-type class meetings, o-sōji-type collective care, duty rotations, han groups), and dōtoku-type reflection circles – and demonstrated statistically significant advantages over conventional instruction across cognitive and, especially, behavioural indicators of moral development ($t=5.78$; $p<0.001$; $d=0.78$). Three conclusions follow. First, the effectiveness of Tarbiya in primary grades is determined less by the volume of value content than by the activity form in which that content is lived; the STEAM project is an adequate such form. Second, sustainable moral behaviour requires an organisational infrastructure of daily routines, and the Japanese experience offers a tested, culturally transposable technology for constructing it. Third, the integration is curriculum-neutral: it reorganises rather than replaces the national Tarbiya programme and is therefore recommended for phased implementation in primary grades, accompanied by teacher training modules on project design and routine facilitation.

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TEACHERS' OCCUPATIONAL EXHAUSTION IN THE CONTEXT OF CONTEMPORARY SOCIAL CHALLENGES: PSYCHOLOGICAL RESILIENCE AND ADAPTIVE STRATEGIES

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ПРОФЕСІЙНЕ ВИСНАЖЕННЯ ВЧИТЕЛІВ У КОНТЕКСТІ СУЧАСНИХ СОЦІАЛЬНИХ ВИКЛИКІВ: ПСИХОЛОГІЧНА СТІЙКІСТЬ ТА АДАПТИВНІ СТРАТЕГІЇ

Abstract

The article provides a comprehensive analysis of the problem of professional burnout among teachers as a pressing challenge for the modern education system. It is argued that teaching is characterized by high levels of emotional, cognitive, and social stress, which, in the context of contemporary education, the intensification of the learning process, and the presence of martial law, significantly increases the risk of professional burnout. The main factors contributing to burnout are considered, specifically emotional overload, excessive responsibility, administrative burden, social instability, and a lack of support. Particular attention is paid to the role of psychological resilience and internal resources of the teacher's personality in counteracting professional burnout. It is demonstrated that the ability to regulate emotions, self-reflect, adapt, and plan professional activities effectively contributes to maintaining psychological balance and professional effectiveness, even under conditions of increased stress. The article provides practical recommendations for developing the psychological resilience of teachers, focusing on the introduction of practices such as emotional self-reflection, breathing and muscle relaxation, mindfulness, time management, and participation in professional support communities. The prevention of professional burnout among teachers should be systematic and combine individual and organizational support strategies, which is an essential prerequisite for maintaining the psychological health of teachers and the stability of the educational process in the context of contemporary social challenges.

Анотація.

У статті здійснено комплексний аналіз проблеми професійного вигорання педагогів як актуального виклику сучасної системи освіти. Обґрунтовано, що педагогічна діяльність характеризується високим рівнем емоційного, когнітивного та соціального навантаження, що за умов модернізації освіти, інтенсифікації навчального процесу та воєнного стану значно підвищує ризик розвитку професійного вигорання. Розглянуто основні чинники, що сприяють виникненню вигорання, зокрема емоційне перенапруження, надмірну відповідальність, адміністративне навантаження, соціальну нестабільність та дефіцит підтримки. Особливу увагу приділено ролі психологічної стійкості та внутрішніх ресурсів особистості педагога у протидії професійному вигоранню. Показано, що здатність до емоційної регуляції, саморефлексії, адаптації та ефективного планування професійної діяльності сприяє збереженню психологічного балансу та професійної ефективності навіть за умов підвищеного стресового навантаження. У статті узагальнено практичні рекомендації щодо розвитку психологічної стійкості педагогів, зокрема впровадження практик емоційної саморефлексії, дихальної та м'язової релаксації, усвідомленості, управління часом і залучення до професійних спільнот підтримки. Зроблено висновок, що профілактика професійного вигорання педагогів має носити системний характер і поєднувати індивідуальні та організаційні стратегії підтримки, що є важливою передумовою збереження психологічного здоров'я педагогів та стабільності освітнього процесу в умовах сучасних соціальних викликів.

Keywords: professional exhaustion; teachers; psychological resilience; internal resources; stress; exhaustion prevention; educational process.

Ключові слова: професійне вигорання; педагоги; психологічна стійкість; внутрішні ресурси; стрес; профілактика вигорання; освітній процес.

Introduction. Professional exhaustion among educators is a significant issue in modern education, as it

directly impacts the psychological well-being of teachers, the quality of teaching, and the overall effective-

ness of the educational process. Teaching is characterized by high emotional, cognitive, and social stress: teachers constantly interact with large numbers of students, respond to their individual needs, perform administrative tasks, and ensure educational outcomes. Increased demands on professional competence, the need to implement innovative teaching methods, continuous self-improvement, and participation in additional professional activities create a significant workload, which over time can lead to chronic stress and the development of experienced burnout.

The problem is particularly relevant in the context of constant changes in the socio-political and economic environment, when teachers are forced to adapt to new requirements, respond quickly to transformations in the education system, and solve complex tasks under time pressure and resource constraints.

The modernization of the education system and increased demands on teachers' professional activities significantly affect the risk of burnout. The intensity of the educational process, the increase in administrative work, the introduction of distance learning, and the use of new technologies all contribute to an increased cognitive and emotional burden on teachers. Teachers are often required to continually update their knowledge, master new teaching methods, and monitor student performance, which creates additional pressure and increases the likelihood of emotional exhaustion. Of particular importance are the conditions of war and social instability, which add a high level of anxiety and security threats to professional burdens. Teachers have to combine their professional duties with concern for their own safety, support for students who are going through traumatic experiences, and often ensuring the safety of their own families. Such conditions significantly accelerate the development of emotional and cognitive exhaustion, reduce internal resources for recovery, and, consequently, increase the risk of professional burnout [1].

In the context of modern education, especially during crises and military situations, the issue of timely detection of burnout symptoms, the development of effective strategies to overcome it, and systematic support for teachers becomes highly relevant for ensuring the quality of education and preserving the psychological health of teachers.

Purpose of the article is to conduct a theoretical and empirical analysis of professional exhaustion among teachers, identify the main factors contributing to its development in the context of education modernization and martial law, and substantiate the role of psychological resilience and internal resources in preventing and overcoming exhaustion.

Research results and discussion. A complex of interpersonal, organizational, and socio-psychological factors causes the development of professional exhaustion in teachers. Among the main ones are a high level of emotional stress associated with constant interaction with students and the need to resolve conflict situations. The intensity of the educational process, the increase in administrative work, the pressure to achieve high learning outcomes, and the assessment of student perfor-

mance all contribute to additional stress. Increased responsibility for the success and safety of children, as well as expectations from parents and administration, significantly increases the psychological burden. Social instability and crisis conditions, in particular war, are becoming particularly relevant factors, as teachers are forced to combine their professional duties with concern for their own safety and support for students who are experiencing traumatic experiences. Additional triggers for burnout include a lack of support from colleagues and administration, insufficient autonomy in decision-making, monotonous work, and limited opportunities for professional development.

Psychological resilience and personal resources are key factors that enable teachers to counteract professional burnout effectively. Psychological resilience helps maintain emotional balance in stressful situations, respond appropriately to professional difficulties, and recover internal resources more quickly after emotional exhaustion [2]. The primary personal resources include self-regulation skills, effective activity planning, the ability to reflect and adapt, as well as a high level of self-confidence and a sense of competence [3]. Educators who possess developed internal resources can maintain motivation for professional growth, avoid emotional distancing, and remain effective at work even under high levels of stress [4,5]. Studies confirm that the level of psychological resilience has an inverse relationship with indicators of emotional exhaustion and depersonalization: the higher the level of resilience, the fewer manifestations of burnout, and the ability to effectively self-support and use personal resources becomes a reliable mechanism for counteracting professional difficulties [6,2, 7]. Thus, the development of psychological resilience and the strengthening of internal personal resources are important components of comprehensive prevention and overcoming professional burnout among teachers.

Developing psychological resilience in teachers requires systematic work aimed at raising awareness of one's own emotional states, developing self-regulation skills, and maintaining inner balance in the face of increased professional stress. First of all, it is advisable to introduce regular practices of emotional self-reflection as an important tool for awareness and regulation of the teacher's own psycho-emotional state. In particular, keeping a diary of emotions or writing brief self-analyses at the end of the working day enables teachers to systematically record their emotions, identify situations that cause stress, and become aware of their own ways of responding to professional challenges. In the process of such reflection, the teacher can analyze which events during the day caused the most emotional stress, what thoughts accompanied these experiences, and what actions helped or, conversely, made it more difficult to overcome stress.

Regular use of written self-reflection helps to develop the skill of distancing oneself from negative emotions. It enables one to transition from spontaneous emotional reactions to a more conscious and controlled approach towards difficult situations. In addition, recording positive results of professional activity, even minor successes in working with students or effective

pedagogical decisions, helps to strengthen the sense of professional competence and maintain internal motivation. Over time, the practice of emotional self-reflection helps to reduce internal tension, prevents the accumulation of emotional exhaustion, and forms more adaptive strategies for responding to stressful situations. Teachers gradually develop the ability to recognize signs of fatigue or emotional overload promptly and take preventive measures to replenish their own resources, which is a crucial condition for maintaining psychological stability and preventing professional burnout.

A crucial direction for strengthening teachers' internal resources is the purposeful development of emotional regulation and self-control skills, which enable them to effectively manage their own emotional reactions in the face of increased professional stress. The practical application of breathing relaxation techniques, progressive muscle relaxation, and mindfulness exercises helps to reduce the level of psycho-emotional arousal, restore concentration, and increase overall performance. In particular, breathing techniques such as slow diaphragmatic breathing involve deep inhalation through the nose using the diaphragm and slow exhalation through the mouth, which activates the parasympathetic nervous system and helps reduce the physiological manifestations of stress. Regularly performing this exercise for 3–5 minutes between classes or before the start of the working day allows teachers to stabilize their heart rate, reduce muscle tension, and restore emotional balance after difficult teaching situations.

Special attention should be paid to developing a positive professional self-image and increasing a sense of competence. Regularly acknowledging one's own achievements, recording successful teaching situations, and receiving feedback from colleagues and students help to strengthen professional self-esteem and internal motivation. Such practices help teachers maintain a sense of the significance of their work even under challenging conditions. A practical resource for developing psychological resilience is also involvement in professional communities and support groups, where teachers have the opportunity to exchange experiences, discuss difficult situations, and receive emotional support. Participation in training courses on stress resilience, emotional intelligence, and self-help skills not only increases professional competence but also helps to develop more adaptive strategies for coping with stress [8,9].

Thus, the combination of self-reflection, emotional regulation, rational planning of activities, support for positive professional self-esteem, and involvement in professional communities creates conditions for the development of psychological resilience and the strengthening of the internal resources of the educator's personality, which is an important prerequisite for the prevention of professional burnout and the preservation of psychological well-being.

The development of effective professional planning and time management skills significantly contributes to strengthening the psychological resilience of teachers, reducing the level of chaos in their work, and increasing their sense of control over their professional

situation. In practice, this involves clearly structuring the working day with a preliminary allocation of time for the main types of activities: teaching lessons, preparing for classes, checking schoolwork, methodological work, and rest. For example, a teacher can create a daily or weekly plan with specific time limits for each task, which helps avoid the accumulation of unfinished business and reduces the feeling of overload.

An important practical tool is to prioritize tasks according to the "important-urgent" principle, where key professional tasks that are most important for the educational process are performed first. In contrast, less important tasks can be postponed or delegated. For example, preparing for a difficult lesson or working individually with students with special needs is defined as a priority activity, while completing additional documentation can be scheduled for less intense periods of the day. Alternating intellectual work with short breaks for recovery also contributes to the effective conservation of resources. The practice of taking short 5-10 minute breaks between classes or after completing complex tasks allows teachers to regain their concentration and reduce their level of psychological and emotional stress. During this time, simple restorative activities, such as walking down the hallway, performing breathing exercises, or stretching muscles, can be beneficial. Realistic planning, which takes into account one's own physical and emotional capabilities, is critical. For example, teachers can consciously limit the number of complex tasks in a single day or refuse additional professional commitments during periods of increased workload. This approach helps to avoid excessive demands on oneself, reduces the risk of chronic exhaustion, and contributes to maintaining stable professional performance in the long term.

Conclusions. The analysis reveals that professional exhaustion among teachers is a complex, multi-dimensional phenomenon that develops under the influence of prolonged professional stress, high emotional strain, and increasing demands on educational activities. This problem becomes particularly acute in conditions of social instability and military action, when professional challenges are compounded by factors such as threats to safety, increased anxiety, and the need to provide psychological support to students. It has been proven that psychological resilience and the internal resources of the teacher's personality are key protective factors in counteracting professional burnout. Developed skills of self-regulation, emotional reflection, effective activity planning, as well as positive professional self-perception contribute to reducing the level of emotional exhaustion and depersonalization, maintaining motivation for professional activity, and preserving psychological well-being. It has been proven that a comprehensive approach to burnout prevention should combine individual self-support strategies for teachers with systematic organizational and psychological support from educational institutions. The implementation of such approaches is a necessary condition for ensuring the stability of teaching staff and the quality of the educational process in the current crisis conditions.

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OPTIMIZATION OF CORRELATION-EXTREME RADAR IMAGE PROCESSING ALGORITHMS

Abstract

Subject and Purpose of the Work. This study examines the statistical characteristics of radar probing signals scattered by the Earth's surface and noise. The aim is to develop a quasi-optimal algorithm for processing complex radar signals for real-time object detection and identification.

Method and Methodology. The algorithm is synthesized using a method for estimating the mutual correlation function between current and reference object images. The synthesis methodology is based on identifying informative signal components and constructing an objective function whose extremum yields the object coordinates and enables their identification.

Results. The algorithm performs correlation-based image processing in both detection and continuous tracking modes. In the detection mode, the objective function minimizes the probabilities of missed detection and false alarm, whereas in the tracking mode it minimizes the coordinate estimation error. This is achieved by sequential processing of the complex phase spectra of images along cross-sections of the two-dimensional spectra defined by a finite set of rational angles. Expressions for these angles are derived. The proposed algorithm enables the processing procedure to be implemented in several parallel channels, each computing the derivative of the mutual correlation function at the central spectral cross-sections of the reference and current images.

Conclusion. A quasi-optimal correlation-extremum algorithm for processing radar images of the Earth's surface is developed. The transfer functions of the optimal filter are derived. A method for sequential computation of the mutual correlation function between current and reference images using cross-sections of the two-dimensional phase spectrum is proposed. The computational cost reduction coefficient relative to the optimal algorithm is determined. Estimates of the false alarm probability in object detection and the root-mean-square coordinate estimation errors are obtained.

Keywords: probing signal; noise; algorithm; correlation function; objective function; correlation-extremum algorithm; optimal filter; mathematical expectation.

INTRODUCTION

The synthesis of algorithms for processing radar information in Earth remote sensing from airborne and spaceborne platforms is based on the formation of radar images of the surface along the flight path of the carrier (aircraft, satellite, etc.) using models of the radar field [1–3, 17, 18]. When constructing models of radar images of the Earth's surface, statistical data obtained from previous experiments are usually employed [4, 19]. In particular, the amplitude of signals scattered from the Earth's surface (forests, cultivated fields, urban areas, water surfaces, etc.) is commonly described by a Rayleigh probability density distribution, while the phase is uniformly distributed [4, 5, 19, 20]. The mean value and, consequently, the variance of the amplitude of signals reflected from surface elements are determined by the specific radar cross-section of the background [6]. This specific radar cross-section depends on the particular terrain observed by the onboard radar.

In addition to signals scattered from relatively homogeneous background areas, isolated objects may also be present, whose reflected signals have significantly higher intensity and substantially exceed the background level. Such objects may include power transmission line masts, vehicles, buildings, roads, bridges, and other individual structures. The dimensions of background areas with nearly constant or slowly varying reflectivity are assumed to be significantly larger than the spatial resolution cell of the radar. All these considerations must be taken into account when selecting the criterion and constructing the objective function for the optimization problem associated with synthesizing algorithms for the secondary processing of radar images of the Earth obtained from airborne radar signals. Moreover, it is desirable that the algorithm support operation both in the mode of object detection during real-time image acquisition and in the mode of object identification and coordinate estimation.

1. JUSTIFICATION AND SELECTION OF THE OBJECTIVE FUNCTION FOR RADAR IMAGE PROCESSING

Known correlation-extremum methods for estimating the coordinates of targets on the Earth's surface in remote sensing involve computing the two-dimensional spatio-temporal mutual correlation function between the current radar image and a predefined reference image [7–9]. The implementation of an optimal method of such processing, however, typically requires high computational resources, which can be a significant limitation when

using small radar platforms. Consequently, quasi-optimal algorithms for radar image processing have attracted considerable interest among remote sensing system developers [9–12].

In general, the synthesis of a quasi-optimal correlation-extremum algorithm includes the following stages: determining the type of pre-processing applied to radar images, defining the optimality criterion and constructing the corresponding objective function for the optimization problem, and selecting a method for finding its extremum.

Typically, the images subject to processing contain redundant information, the removal of which, under relatively low noise levels, does not reduce the probability of target detection or significantly increase errors in determining their positions on the Earth's surface. The permissible level of information reduction is determined by the acceptable degree of degradation in the system's noise immunity. In particular, the information reduction process can be represented as a filtering procedure. In this case, the solution to the algorithm synthesis problem reduces to the synthesis of a filter transfer function that ensures the desired transformation of the input signals.

It should be noted, however, that reducing the information redundancy of spatio-temporal signals leads to negative effects, such as a decrease in one of the most important system characteristics: the spatial resolution of the resulting radar image. Therefore, the process of reducing information redundancy in remote sensing signals should be closely related to the set of tasks for which the system is intended.

The selection of an optimality criterion and the construction of the objective function in algorithm synthesis generally involve defining a probabilistic measure by which the degree of correspondence between the compared images is assessed. In correlation-extremum processing of radar images, the mutual correlation function of the current and reference images can be expressed as a mixed second-order central moment [13].

$$K_{1,1}(a_x) = E \left\{ \left[s_r(x) - E \{ s_r(x) \} \right] \left[s_t(x + a_x) - E \{ s_t(x + a_x) \} \right] \right\}, \quad (1)$$

where $s_r(x)$, $s_t(x)$ are the reference and current images, respectively; $E \{ \cdot \}$ denotes the mathematical expectation operator; a_x is the image shift along the x -coordinate.

If function (1) is normalized by its root-mean-square deviation $\sigma[\cdot]$, then the function below can be used as the objective function of the optimization problem for the synthesis of a radar image processing algorithm.

$$K_{1,2}(a_x) = \frac{K_{1,1}(a_x)}{\sigma[s_r(x)] \sigma[s_t(x)]}. \quad (2)$$

The root-mean-square deviation of the function $s_r(x)$ [13] may also be used as an objective function.

$$K_{1,3}(a_x) = E \{ s_r(x) s_t(x + a_x) \}. \quad (3)$$

2. SYNTHESIS OF A CORRELATION-EXTREMUM ALGORITHM FOR RADAR IMAGE PROCESSING

When synthesizing an algorithm for processing radar images of the Earth's surface, it is necessary to take into account that the algorithm must provide correlation processing of images both in the object detection and identification mode and in the tracking (observation) mode. In the first case, the main characteristics of the algorithm are the probability of target miss and the probability of false alarm. In this case, errors in determining the target location play a secondary role. In the second case, the algorithm must primarily ensure high accuracy in estimating the target location. Therefore, in the detection–identification mode the spatio-temporal objective function should provide the maximum ratio of the main-lobe level to the side-lobe levels. In the limiting case, the ideal form is a delta function. In the tracking mode, the measurement of the object coordinates is performed using the derivative of the cross-correlation function, which allows some widening of its main lobe. Obviously, it is advantageous to implement the algorithm in the spectral domain in order to exploit the advantages of fast Fourier transform (FFT) algorithms. In the general case, the algorithm operates in two stages. At the first stage, preprocessing of the current and reference images is performed in order to form images with reduced informational redundancy. Then, additional processing of the current image is carried out to obtain a correlation function with the narrowest possible main lobe. Both of these stages can be represented as a linear filtering process, as shown in Fig. 1.

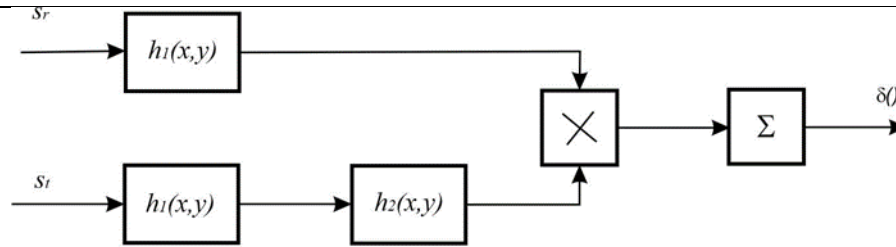


Figure 1. Generalized structure of the radar image processing algorithm.

In Fig. 1, the following notations are introduced: $S_r(\cdot)$ and $S_t(\cdot)$ denote the reference and current images, respectively; $h_1(\cdot)$ and $h_2(\cdot)$ denote the weighting functions of the first and second processing stages, respectively. To reduce informational redundancy, a filter may be used whose output signal is represented as a set of samples taken along radial lines originating from the coordinate origin and uniformly distributed over the interval $0...360^\circ$. In this case, the requirement of reducing redundant image information with a predefined nonuniformity is satisfied without increasing the computational cost. The transfer function of the filter that provides such image processing, using the filtering properties of the delta function, can be written in the following form.

$$H_1(\omega_x, \omega_y) = \sum_{k=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} \delta\{g_k(\omega_x, \omega_y)\} \delta\{f_m(\omega_x, \omega_y)\}, \quad (4)$$

where $g_k(\omega_x, \omega_y)$ is the equation of a bundle of straight lines, $f_m(\omega_x, \omega_y)$ is the equation of concentric circles with the center at the origin of coordinates, and ω_x, ω_y are the coordinates in the complex spectral domain.

Taking into account that the properties of the delta function extend to the two-dimensional case and to a finite-dimensional sample set, function (4) can be written in the following form

$$H_2(\omega_x, \omega_y) = \sum_{k=1}^n \sum_{m=1}^p \delta\{\omega_y - tg(\theta_n, k)\omega_x\} \delta\{\omega - m\omega_0\}, \quad (5)$$

where n is the number of straight lines in the bundle; $\theta_n = \pi/n$, $\omega = \sqrt{(\omega_x^2 + \omega_y^2)}$, ω_0 is the Nyquist sampling frequency [14]; $p = W/\omega_0$, W is the highest frequency of the signal spectrum, $S(\omega_x, \omega_y)$ $k \neq n/2$.

The signal at the output of the filter with transfer function (5) can be written in the following form.

$$\hat{S}(\omega_x, \omega_y) = S(\omega_x, \omega_y) \sum_{m=1}^p \sum_{k=1}^n \delta\{\omega_y - tg(\theta_n, k)\omega_x\} \delta\{\omega - m\omega_0\} \quad (6)$$

and, as n tends to infinity, it asymptotically approaches the original signal.

At the second stage of processing, the algorithm must ensure such processing of the current image that the cross-correlation function of the reference and current images degenerates into a delta function. In particular, the current image at the output of the filter can be written as follows

$$\bar{s}_t(x, y) = \hat{s}_t(x, y) \otimes h_2(x, y), \quad (7)$$

where $\otimes$ denotes the convolution operation,

or in the spectral plane

$$\bar{S}_t(\omega_x, \omega_y) = \hat{S}_t(\omega_x, \omega_y) \cdot H_2(\omega_x, \omega_y). \quad (8)$$

The cross-correlation function of the reference and the current images can be written as follows

$$r(x, y) = s_t(x, y) \otimes \hat{s}_r(x, y), \quad (9)$$

or in the spectral plane

$$R(\omega_x, \omega_y) = \bar{S}_t(\omega_x, \omega_y) \cdot \hat{S}_r(\omega_x, \omega_y). \quad (10)$$

Since the correlation function is required to approach a delta function, by representing the spectra in complex form we obtain

$$\delta(x, y) = \Phi^{-1} \left\{ \left| \hat{S}_t(\omega_x, \omega_y) \right| \exp \left[j(\varphi_x^t + \varphi_y^t) \right] \right\} \left| \hat{S}_r^*(\omega_x, \omega_y) \right| \exp \left[j(\varphi_x^r + \varphi_y^r) \right] H_2(\omega_x, \omega_y), \quad (11)$$

where $\Phi^{-1}\{\cdot\}$ denotes the operator of the inverse Fourier transform.

It can be easily shown that equation (11) is satisfied by a transfer function $H_2(\omega_x, \omega_y)$ of the following form

$$H_2(\omega_x, \omega_y) = \left[\hat{S}_t(\omega_x, \omega_y) \hat{S}_r(\omega_x, \omega_y) \right]^{-1}. \quad (12)$$

Thus, a device with the transfer function $H_2(\omega_x, \omega_y)$ represents a phase filter, at the output of which the phase component of the complex spectrum of the image remains unchanged, while the amplitude spectrum is normalized. The importance of the phase lies in the fact that it contains all the information about the displacement of the target image.

Let the radar image $s(x, y)$ have the spectrum $S(\omega_x, \omega_y)$. The spectrum of the image shifted along the x -axis by an amount a_x and along the y -axis by an amount a_y is calculated as follows

$$\Phi \left\{ s(x - a_x, y - a_y) \right\} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} s(x - a_x, y - a_y) \exp \left[-j(\omega_x x + \omega_y y) \right] dx dy, \quad (13)$$

where $\Phi \{ \cdot \}$ denotes the Fourier transform operator.

After the change of variables $x - a_x = u$, $y - a_y = v$, equation (13) can be written as

$$\begin{aligned} \Phi \left\{ s(x - a_x, y - a_y) \right\} &= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} s(u, v) \exp \left[-j(\omega_x (u + a_x) + (\omega_y (v + a_y))) \right] du dv = \\ &= S(\omega_x, \omega_y) \exp \left[-j(\omega_x a_x + \omega_y a_y) \right] \end{aligned} \quad (14)$$

From equation (14) it follows that the displacement affects only the phase spectrum. The transfer function (12) can be generalized by introducing a power exponent l in the denominator. Thus,

$$H_2(\omega_x, \omega_y) = \left[\hat{S}_t(\omega_x, \omega_y) \hat{S}_r(\omega_x, \omega_y) \right]^{-l}. \quad (15)$$

Thus, when $l=1$, the cross-correlation function of the current and the reference images takes the form of a delta function, and the algorithm operates in the search mode. For $l < 1$, the delta function broadens into a Gaussian surface in the general case. This is convenient for implementing the tracking mode of the algorithm with a discrimination characteristic determined by the derivative of the cross-correlation function of images with reduced informativeness.

Thus, the quasi-optimal correlation-extremum algorithm for decision-making with respect to a target in the current radar image is formulated as the solution of the following extremum problem

$$\gamma^{opt}(a_x, a_y) = \frac{\arg \max}{\{\omega_x, \omega_y \in \Omega\}} \left\{ \Phi^{-1} \left[\bar{S}_t(\omega_x, \omega_y) \cdot \hat{S}_r^*(\omega_x, \omega_y) \right] \right\}, \quad (16)$$

where

$$\begin{aligned} \bar{S}_t(\omega_x, \omega_y) &= S_t(\omega_x, \omega_y) H_v(\omega_x, \omega_y), \\ \hat{S}_r(\omega_x, \omega_y) &= S_r(\omega_x, \omega_y) H_u(\omega_x, \omega_y), \\ H_u(\omega_x, \omega_y) &= \sum_{m=1}^p \sum_{k=1}^n \delta \{ \omega_y - \omega_x \operatorname{tg}(\theta_n k) \} \delta \{ \omega - m \omega_0 \}, \\ H_v(\omega_x, \omega_y) &= \frac{\sum_{m=1}^p \sum_{k=1}^n \delta \{ \omega_y - \omega_x \operatorname{tg}(\theta_n k) \} \delta \{ \omega - m \omega_0 \}}{\left| \bar{S}_t(\omega_x, \omega_y) \cdot \hat{S}_r^*(\omega_x, \omega_y) \right|^l}, \end{aligned}$$

$$0 \leq l < 1; \quad k \neq n/2; \quad p = W / \omega_0; \quad \theta_n = \pi / n.$$

In the general case, algorithm (16) corresponds to the search mode. In the non-search mode, the difference consists in the fact that the target displacement values a_x, a_y are determined from the zero values of the first partial derivatives of function (16) with respect to the parameters a_x, a_y as well as from the total derivatives with respect to time. It is obvious that for $l=0$ the algorithm becomes equivalent to the optimal correlation algorithm.

3. FEATURES OF THE PRACTICAL IMPLEMENTATION OF THE RADAR IMAGE PROCESSING ALGORITHM

Analysis of algorithm (16) shows that its implementation is associated with a number of difficulties arising when processing images with a filter whose transfer function $H_u(\omega_x, \omega_y)$ is defined in the spectral domain. Moreover, it is assumed that the image spectra are given not in Cartesian coordinates, but in polar coordinates. That is, the Fourier spectrum of the image must be represented as

$$S(u, \theta) = 2\pi \sum_{n=-\infty}^{\infty} \bar{C}_{mn}(u) \exp(-jn\theta), \quad (17)$$

$$\text{where } \bar{C}_{mn}(u) = \int_0^{\infty} \rho C_n(\rho) J_n(\rho u) d\rho, \quad C_n(\rho) = (2\pi)^{-1/2} \int_{-\pi}^{\pi} s(\rho, \varphi) \exp(-jn\varphi) d\varphi.$$

Transforming images given in polar coordinates requires the use of Bessel functions [15] and, in particular, the application of the Hankel transform [16]. Clearly, the computational efficiency of operations involving these functions is significantly lower than that of algorithms based on the fast Fourier transform.

One effective method for simplifying the correlation processing of two-dimensional arrays is the sequential computation of correlation functions of the rows and columns of these arrays. In this approach, reducing two-dimensional functions to one-dimensional functions significantly decreases computational costs. To implement this method for image processing, one can select, as one-dimensional arrays, the sets of spectral component values located along a line $g(\omega_x, \omega_y)$, computed according to equations (4) and (5). These spectral components represent

central slices of the image spectrum, equally spaced over the interval of angles $\theta \in [0 \dots 360^\circ]$.

It is evident that by increasing the number of central slices of the spectra n , one can obtain a complete description of the radar image spectrum with any desired accuracy, and, correspondingly, a full representation of the spatiotemporal cross-correlation function of the reference and current images. In this case, equation (16), which represents the quasi-optimal algorithm, can be divided into n relations, each corresponding to the derivative of the correlation function taken along the same angles of the central slices of the reference and current image spectra. The zero of the derivative of the spatiotemporal correlation function determines the displacement α_θ of the slices, and thus the displacement of the compared images along the direction of the angle θ . To obtain the target displacement in Cartesian coordinates, it is sufficient to perform correlation processing on only two spectral slices, selected at arbitrary angles θ_k, θ_l . If $\theta_k < \theta_l$, the displacement is determined along the corresponding x or y coordinate from the system of equations

$$\begin{cases} \alpha_x = \pm \arccos\left(\frac{\alpha_{\theta_k}}{\lambda_x}\right) + \theta_k + 2\pi n \\ \lambda_x = a_{\theta_l} / \cos(\alpha_x - \theta_l) \end{cases}, \begin{cases} \alpha_y = \pm \arccos\left(\frac{\alpha_{\theta_k}}{\lambda_y}\right) + \theta_k + 2\pi n \\ \lambda_y = a_{\theta_l} / \cos(\alpha_y - \theta_l) \end{cases}, \quad (18)$$

where $\lambda_x = a_x / \cos(\alpha)$, $\lambda_y = a_y / \sin(\alpha)$.

For small values of θ and α , the approximate solution of system (18) takes the following form

$$a_x = a_y = \alpha_{\theta_k} - \theta_k \frac{\alpha_{\theta_l} - \alpha_{\theta_k}}{\theta_l - \theta_k}. \quad (19)$$

Among the infinite set of angles at which the projections of image spectra are computed, a finite set of rational angles can be identified, the use of which ensures a unique determination of the spectra with a minimal number of projections. These angles can be calculated using the formula

$$\theta = \arctg\{T_q / \theta_q\}, \quad (20)$$

where $q = 1, 2, 3, \dots, n$; T_q, θ_q , - are integers such that $|\theta_q| \leq n$, and n is the number of projection angles.

It turns out that if the angles θ_q are chosen such that they are offset from each other by a right angle, this allows the computation of simplified estimates of the displacements a_x, a_y using the following formulas

$$a_x(q) = a_{\theta_{2q-1}} \cos(\theta_{2q-1}) - a_{\theta_{2q}} \sin(\theta_{2q-1}), \quad (21)$$

$$a_y(q) = a_{\theta_{2q-1}} \sin(\theta_{2q-1}) - a_{\theta_{2q}} \cos(\theta_{2q-1}). \quad (22)$$

CONCLUSIONS

Thus, the considered radar image processing algorithm for target coordinate estimation allows a significant reduction in computational costs. This is achieved by reducing the informational content of the images through the formation of one-dimensional spectral projections and processing them using fast Fourier transform algorithms. The computational cost reduction factor K_0 , relative to the classical correlation-extremum algorithm, can be calculated using the methodology presented in [21]. Figure 2 shows the dependence of the coefficient K_0 on the size of the processed images, while Figure 3 presents the root-mean-square value of the mismatch σ_0 between the current and reference images as a function of the distortion intensity. The distortion intensity is defined as the ratio of the total number of image elements to the number of distorted elements when reducing the overall informational content of the input image, which can effectively be considered as a parameter of the decision-rule accuracy.

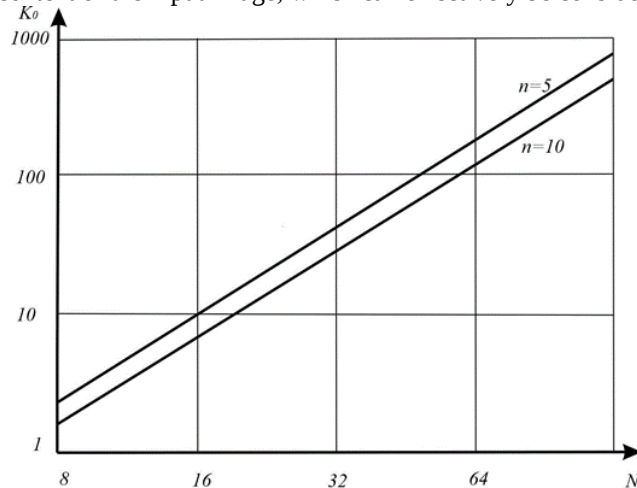


Figure 2. Dependence of the coefficient K_0 on the size of the images.

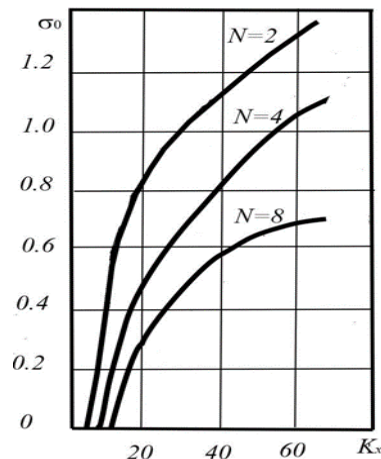


Figure 3. Image registration error as a function of distortion intensity.

As can be seen from Figure 2, the quasi-optimal algorithm provides at least an order-of-magnitude reduction in computational costs when processing typical radar images. As performance criteria, one can use the probability of false alarm P_{FA} in image registration and the root-mean-square error σ_0 of alignment between the current and reference images. In particular, the probability of a false registration alarm is understood as the likelihood that the extremum of the target function is displaced from the true position by an amount exceeding a predetermined threshold. The image alignment error is characterized by the root-mean-square value of the mismatch between the current and reference images.

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PHILOLOGICAL SCIENCES

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THE ARABIC QASIDAS OF FUZULI

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ARABSKIE KASIDY FUZULIEGO

Annotation.

Muhammed bin Suleyman Fuzūlī (d. ca. 1556) composed qasīdas in Turkish, Persian, and Arabic. While his Turkish and Persian qasīdas are widely studied, his Arabic qasīdas have received relatively little scholarly attention. This article examines the twelve Arabic qasīdas (eleven complete, one fragment, totaling 465 bayts/couplets), discussing their textual transmission, poetic structure, and thematic content. The study showcases Fuzūlī's proficiency in Arabic metres, rhetorical techniques, and semantic intricacies. His qasīdas reflect Sufi thought and Shi'ite devotion, particularly to the Prophet Muhammad (ﷺ) and Imam 'Ali (عليه السلام), as well as lyrical explorations of earthly love. The study contextualises Fuzūlī's Arabic qasīdas within his trilingual poetic heritage, emphasising their integral role in appreciating the poet's artistic and spiritual achievements. Consequently, these qasīdas should be studied alongside his Turkish and Persian poetry to gain a comprehensive understanding of Fuzūlī's poetic genius and his contributions to the literary traditions of the Islamic world. The article also touches upon the poet's date of birth, which appears differently in various sources. Based on the date on a manuscript obtained from the National Library of France (BnF), it emphasises the importance of revising this date.

Streszczenie.

Muhammad ibn Sulejman Fuzūlī (zm. ok. 1556) tworzył kasydy w językach tureckim, perskim oraz arabskim. Podczas gdy jego kasydy tureckie i perskie są szeroko badane, kasydy arabskie pozostają stosunkowo słabo opracowane w literaturze naukowej. Niniejszy artykuł analizuje dwanaście arabskich kasyd (jedenaście zachowanych w całości oraz jeden fragment, łącznie 465 bajtów/dwuwerszy), omawiając ich przekaz tekstowy, strukturę poetycką oraz treść tematyczną.

Badanie ukazuje biegłość Fuzūliego w zakresie arabskich metrów poetyckich, technik retorycznych oraz subtelności semantycznych. Jego kasydy odzwierciedlają myśl suficką oraz szyicką pobożność, zwłaszcza wobec Proroka Muhammada (ﷺ) oraz imama 'Ali (عليه السلام), a także zawierają liryczne refleksje nad miłością ziemską.

Artykuł umieszcza arabskie kasydy Fuzūliego w kontekście jego trójjęzycznego dziedzictwa poetyckiego, podkreślając ich integralną rolę w pełnym zrozumieniu artystycznych i duchowych osiągnięć poety. W związku z tym kasydy te powinny być badane równolegle z jego twórczością turecką i perską, aby uzyskać całościowe spojrzenie na geniusz poetycki Fuzūliego oraz jego wkład w tradycje literackie świata islamu.

Artykuł porusza również kwestię daty urodzenia poety, która w różnych źródłach podawana jest odmiennie. Na podstawie daty znajdującej się w rękopisie przechowywanym w Bibliotece Narodowej Francji (BnF) podkreśla się konieczność rewizji tej daty.

Keywords: Fuzūlī, Arabic Poetry, Qasīda, Bertels, Bandaroghlu.

Słowa kluczowe: Fuzūlī, poezja arabska, kasida, Bertels, Bandaroghlu.

Introduction: Muhammed bin Suleyman Fuzūlī (d. ca. 1556) is recognized as one of the most prominent poets of the classical Azerbaijani literature, composing in Turkish, Persian, and Arabic. A Scottish orientalist E. J. W. Gibb (1857-1901) characterized Fuzulī's trilingual creativity as follows: "He composed with equal ease and elegance in Turkish, Persian, and Arabic, his Turkish poems being highly favoured by the critics of Rūm, his Persian *divān* being the delight of the poets of every land, his Turkī pieces being recited by the Mughals, and his Arabic bayts being famous with the eloquent among the Arabs" (Gibb, 1904, p.72)

Although his Turkish and Persian works have been extensively studied, his Arabic qasīdas have received comparatively little scholarly attention, despite being

important for understanding Fuzūlī's literary and spiritual development. These qasīdas were discovered by chance in a manuscript at the Asia Museum (now the Institute of Oriental Manuscripts) and were first studied by the Russian scholar Evgenii Eduardovich Bertels. In 1930, he published preliminary information on these qasīdas and prepared critical editions of two of them (the qasīdas No. 1 and No. 6 in the *Divān*), translating them into Russian in the process (Bertels, 1930, pp. 39–71).

These texts have become more accessible thanks to subsequent critical editions by Hamid Arasli in 1958 (Baku) and Abdul Latif Bandaroglu in 1994 (Baghdad). Alongside these publications, research into Arabic

qaşidas also began. One of the scholars who has conducted noteworthy research on Fuzūlī's qaşidas is Vejihe Feyzullayeva. While examining the poet's qaşida production as a whole, she also addressed those composed in Arabic. In 2012, Ruhengiz Jumshudlu became the first researcher to conduct an extensive, independent, scholarly study of these Arabic qaşidas.

Although various sources in Türkiye mention Fuzulī's Arabic works, they have not yet been the subject of a systematic and extensive investigation. Nevertheless, Ayhan Erdogan translated and analysed two qaşidas (the qaşidas No. 4 and No. 11 in the Dīvān) (Erdogan, 2010, pp. 171–181).

This study provides a succinct analysis of Fuzūlī's Arabic qaşidas, covering their textual history, poetic form, thematic content, and linguistic features. Through an examination of these qaşidas, the article will seek to reconstruct the poet's multilingual literary vision, while also highlighting the spiritual and aesthetic significance of his Arabic poetry.

Main Text: Several scholars argue that Fuzūlī possessed a complete Arabic Dīvān, and the surviving qaşidas represent fragments of that collection. For instance, Hamid Arasli asserts that, besides the qaşidas known to contemporary scholarship – many still unpublished – Fuzūlī composed a separate Arabic Dīvān (Arasli, 1958, p. 141). Similarly, Abdulkadir Karahan indicates that the extant Arabic qaşidas, though limited in number, are excerpts from this Dīvān; medieval sources such as Şādiqī and Bursali Mehmed Tahir also corroborate the existence of Fuzūlī's Arabic Dīvān, sometimes exaggerating its extent to 30,000 (3000 [?]) bayts (Karahan, 2020, p. 245).

Motivated by these claims, we surveyed the manuscript catalogues of major libraries worldwide in an attempt to locate Fuzūlī's Arabic works. Although this search did not yield any new qaşidas, we found a manuscript in the *Bibliothèque Nationale de France* that contains four Arabic bayts attributed to Fuzūlī (cote: Persan 49; former catalogue numbers: 1675, O.13, 1682 and 1548). A comparison with editions by Arasli and Bandaroglu shows that these four bayts correspond to couplets 11–14 of the second qaşida.

Although the manuscript does not provide substantial new information on Fuzūlī's Arabic qaşidas, it contains data relevant to his birth date, which remains a matter of debate. While scholars such as Alessio Bombaci (Aliyeva, 2025, p. 1058), and Hasibe Mazioglu (Mazioglu, 2002, p. 2) propose 1480; A. Karahan (Karahan, 1989, p. 72), and Bandaroglu (Bandaroglu, 1994, p. 5) suggest 1494 – a date also adopted by the “Azerbaijan Literary History” and *Bibliothèque Nationale de France*.

According to Edgar Blochet (1870–1937), the manuscript was copied in 894 AH (1488 AD) by Derwish Yusuf ibn Ahmad ibn Muhammad al-Khorasani al-Isfahani (Blochet, 1905, p. 86). This implies that Fuzūlī may have been born before 1480, a possibility and that should be given careful consideration in future biographical studies.

Scholars are familiar with twelve of Fuzūlī's Arabic qaşidas (eleven complete and one fragment), totalling 465 bayts. Various researchers have documented

the distribution of bayts among the qaşidas differently: Y. E. Bertels numbered the qaşidas and recorded the number of bayts in each: No. 1 – 63, No. 2 – 51, No. 3 – 43, No. 4 – 21, No. 5 – 30, No. 6 – 38, No. 7 – 27, No. 8 – 27, No. 9 – 53, No. 10 – 52, No. 11 – 53, and No. 12 (fragment) – 7 couplets (Bertels, 1962, p. 507).

Fuad Koprulu repeated Bertels's enumeration, whereas A. Karahan reported a total of 470 bayts. Other scholars, such as V. Feyzullayeva and R. Jumshudlu, suggested totals of 465 (Feyzullayeva, 1985, p. 22) and 460 (Jumshudlu, 2012, p. 13), respectively.

Ayhan Erdogan's view, however, is entirely different. He states: “*The divan, consisting of a total of 516 couplets, comprises 12 qaşidas together with the final 7-couplet khātima. The lengths of the qaşidas also vary. Listed in order, the number of couplets in the qaşidas is as follows: 114–51–44–21–30–38–27–27–53–52–52–7 = 516 bayts*” (Erdogan, 2010, p. 172).

However, the accuracy of the figures presented by Erdogan is open to doubt. This is because in the editions of Fuzūlī's Arabic works prepared by both Arasli and Bandaroglu, there is no Arabic qaşida consisting of 114 couplets. In both editions, the first and longest qaşida comprises 63 couplets.

Our comparative analysis of the number of couplets in the qaşidas shows that the figures in the editions prepared by Arasli and Bandaroglu fully coincide, and that these figures are identical to those provided by Bertels, with the exception of two qaşidas. Bertels counted one couplet fewer in the third qaşida and one couplet more in the eleventh qaşida. In fact, the third qaşida consists of 44 couplets, while the eleventh qaşida consists of 52 couplets.

Taking these corrections into account, the number of couplets in Fuzūlī's Arabic qaşidas can be presented as follows:

No. 1 – 63, No. 2 – 51, No. 3 – 44, No. 4 – 21, No. 5 – 30, No. 6 – 38, No. 7 – 27, No. 8 – 27, No. 9 – 53, No. 10 – 52, No. 11 – 52, and No. 12 – 7 couplets.

Thus, the total number of couplets in the qaşidas amounts to 465.

Eight of Fuzulī's Arabic-language qasidas (nos. 1, 2, 6, 7, 9, 10, 11 and 12) are written in the *tawīl* metre; three (nos. 3, 4 and 5) in *kāmil*; and one qasida (no. 8) in *wāfir* (Bertels, 1962, p. 508). These metres of ‘arūd were considered to be more characteristic of Arabic poetry. M. F. Koprulu notes that non-Arab (‘Ajam) poets made very limited use of metres widely known among Arabs, such as *tawīl*, *madīd*, *basīt*, *wāfir*, and *kāmil* (Koprulu, 1980, p. 134).

However, Fuzūlī did not use metres typical of Turkish and Persian poetry, such as *muḍārī‘* and *muḡtass*, but instead favoured those commonly used by Arabic poets. Bertels explains this preference in two ways:

1) Fuzulī perceived the rhythm of Arabic poetry more clearly in these metres and sought to give his qaşidas an Arabic 'character' by using them;

2) These heavy metres were more suited to the solemn and ceremonial style of the qasida, leading him to favour them (Bertels, 1962, p. 508).

However, given that another one of our classical poets, Khagani Shirvani, who is considered a master of

the qasida, also wrote in Persian using metres such as *madīd*, *ṭawīl*, *basīt*, *wāfir* and *kāmil*, which are considered “uncharacteristic of Persian poetry” Bertels's second argument seems more convincing. In other words, Fuzūlī did not attempt to impart an artificial Arabic character to his works; rather, he favoured the metres that were most appropriate to the genre of the works he was composing.

The lack of diacritical marks, and vowels (ḥarakāt) in classic Arabic texts is one of the factors that complicates the translation process and leads to distortion. It is worth mentioning a thought about the Arabic alphabet by Abū Rayḥān al-Bīrūnī (973-1048), one of the famous scholars of the Middle Ages: “Arabic writing has a great drawback. It contains letters identical in their forms. They are easily confused, and there results the need for diacritical marks to distinguish those letters from each other, as well as the need for ways and means to express the grammatical terminations at the ends of words. Where these marks are omitted, the meaning becomes obscured” (Rosenthal, 1961, p. 22). When religious texts are composed, potentially contradictory points are carefully taken into consideration, and in order to prevent misinterpretation or distortion, such passages are provided with diacritical marks, and vowels; in other cases, the texts are generally presented without them. This situation may result in multiple readings of a single word and, consequently, in different translation variants. This also applies to Fuzūlī's works.

As we mentioned earlier that Fuzūlī's Arabic qasīdas were published by H. Arasli and A. L. Bandaroglu, though both editions contain certain inaccuracies. This explains why different translators interpret certain bayts differently, for example, in the case of Qasīda No. 10, bayt No. 15:

لسانك حلو لحظ طرفك ساحر كأنك حلي وأرضك بابل

(Bandaroglu, 1994, p. 113)

Koprulu interpreted the part of the bayt كأنك حلي و أرضك بابل as *if you were from Hillah and your land was Babylon*, and concluded that Fuzūlī was born in Hillah and spent most of his life there. However, A. Karahan and A. Golpinarli rightly objected to this idea.

Azerbaijani scholars have also translated the couplet in various ways. Memmed Mubariz Alizadeh, for example, produced the following poetic translation of the bayt:

Your tongue is sweet, those meaningful eyes enchanting,

Has your homeland become Babylon to you, are you a sweetmaker?

(Fuzūlī, 2005, p. 302)

V. Feyzullayeva did not consider this translation to be accurate, and made the following suggestion:

Your tongue is sweet, your crooked gaze is enchanting,

You seem like Hillah, and your land is Babylon.

(Feyzullayeva, 1985, p. 41)

However, translating the phrase لحظ طرفك in the first line as *crooked gaze* is inappropriate both grammatically and semantically. This is because the phrase is in the *idāfah* construction (noun + noun) structure in Arabic, whereas *crooked gaze* is a noun +

adjective phrase. Moreover, the phrase *crooked gaze* is also semantically incompatible with the description *sweet-tongued, captivatingly beautiful*. The correct meaning of the phrase is as follows: لحظ طرفك *glance, your eyes* → *the glance of your eyes*.

The researcher rightly points out that translating the word حلي as *sweetmaker* in the second line distorts the meaning, and his proposed alternative translation is open to debate. This is because, in Arabic, the absence of a *tashdid*, (or *shaddah*) can completely change the meaning of a word. Depending on the placement of the *tashdid* in this couplet, the word حلي can be read in two ways:

1. حِلِّي (hillī) – if there is a *tashdid* on both the letter *lām* and the letter *yā*.

This form is consistent with the edition by Bandaroglu. Researchers such as Bertels (Bertels, 1962, p. 515), Feyzullayeva (Feyzullayeva, 1985, p. 41), and Jumshudlu (Jumshudlu, 2012, p. 188) have preferred this reading.

2. حُلِّي (jewellery, adornment) – only if there is a *shaddah* on the letter *yā*.

In Arasli's edition, the couplet is written this way. A. Erdoghan, who translated Fuzūlī's two Arabic qasidas, adopted this reading:

Your tongue is sweet, even a single glance is enchanting.

You are like a jewel, and the place you live is Babylon.

(Erdoghan, 2010, p. 177)

The city of Babylon, mentioned in the couplet, is famous for its association with the magic of ancient Mesopotamia. The Qur'ān (Sūrah al-Baqara, āyah 102) also refers to Babylon's association with magic. The motif of *Babylonian magic* features prominently in Eastern literature. In my estimation, Fuzūlī also compares the beloved's gaze to Babylonian magic and has expressed that the sweet-tongued, enchanting beauty is likened to a precious jewel found in the legendary Babylon:

*Your tongue is sweet, your gaze enchanting;
you are like a precious jewel, and your dwelling place is Babylon.*

Despite their limited volume, the poet's Arabic works are rich in rhetorical devices, such as *isti'ārah* (metaphor), *tashbīh* (simile), *jinās* (paronomasia), *tibāq* (antithesis), among others. According to early studies on Fuzūlī, *ishtiqaq* (derivational wordplay) is the most frequently employed rhetorical device in his Arabic qasīdas (Bertels, 1962, p. 511; Jumshudlu, 2012, p. 177). Fuzūlī made extensive use in his works of words derived from the same root yet conveying mutually contradictory meanings. The poet's pseudonym represents the most striking example of this practice. In its first sense, the word *fuzūlī* denotes a person of knowledge and virtue, while in its second sense it refers to someone who speaks vainly or engages in idle talk. In the preface to his Persian Divan, the poet explicitly states that he adopted the pen name Fuzūlī precisely because of this dual meaning. One of his Arabic couplets also alludes directly to this issue:

عُلُوّ مقامِي فِي الْفَضَائِلِ ظَاهِرٌ مُشْبِغٌ اسْمِي بِالْفُضُولِ لَقَدْ سَهَا

(Bandaroglu, 1994, p. 73)

*My excellence in virtue is manifest;
Those who circulate my name under idle talk
(fudūl) have erred.*

Another example: the poet, employing words derived from the same root فط, yet expressing completely opposite meanings – *tafrīt* (neglect) and *ifrāt* (excess), says:

قلبي بتفريط المنى منكسر جسمي بإفراط السقام نحيل
(Bandaroghlu, 1994, p. 91)

*My heart is broken by neglect of desire;
My body, weakened by excess of affliction.*

Fuzuli's couplet reflects the influence of Qur'ānic verses (Sūrah al-Furqān, āyah 67; Sūrah al-Isrā āyahs 29 and 110) and resonates with the wisdom of خَيْرُ الْأُمُورِ — أَوْسَطُهَا، لَا إِفْرَاطَ وَ لَا تَفْرِيْطَ — *The best of deeds is the moderate one; avoid both excess and negligence.*

Fuzuli's Arabic qasīdas are not merely literary compositions; they also serve as poetic reflections of Islamic thought, Sufism, and devotion to the Ahl al-Bayt. Across the qasīdas, one encounters both worldly themes and spiritual, mystical sentiments. Some bayts express love for the Prophet Muhammad (ﷺ) and 'Alī ibn Abī Tālib (ع), while others depict pure affection for an earthly beloved, with its attendant suffering and longing. Proper interpretation of these bayts often requires reference to the Qur'ān, authentic Hadith, and exegesis.

The poet's devotion to Shi'ism and to Imam 'Alī (ع) is evident throughout his work. In bayts that praise Imam 'Alī (ع), Fuzuli demonstrates a meticulous adherence to religious sources, portraying the Imam's exalted status with profound erudition. Consider the eleventh qasīda, dedicated him:

ولِي وصي كامل متكمل تقى نقي زاهد متسرع
أقام بناء الدين جوداً وطاعة فأعطى فقيراً خاتماً وهو يركع
(Bandaroghlu, 1994, p. 120)

*He is a perfect guardian and executor,
devout, pure, ascetic, and swift in acts of piety.
He established the structure of religion with generosity and obedience,
giving a ring to a poor man while in the state of ruku'.*

The first bayt of the qasīda praises the exalted status of Imam 'Alī (ع). The phrase *zahid muteserri* (the hasty ascetic) in the couplet is linked to an authentic (ṣaḥīḥ) hadith. According to a narration from al-Bukhari: "I used to take the "Suhur" meal with my family and hasten so as to catch the Fajr (morning prayer) with Allah's Messenger (ﷺ)" (Bukhari: 577). This hadith reveals the qualities of a person who rushes to worship, possesses piety, and strives to fulfill religious obligations as quickly as possible. Fuzuli's characterization of Imam 'Alī (ع) as a "hasty ascetic" in the couplet emphasizes his meticulousness in worship and sensitivity in servitude.

The second bayt describes the generosity and philanthropy of Imam 'Alī (ع) and recalls the Incident of Giving the Ring While in *Ruku'* as evidence of this generosity: Imam 'Alī (ع) gave the ring on his finger to a poor man who approached him while he was in *ruku'* during prayer, without breaking his prayer. It is narrated that this led to the revelation of āyah 55 of Sūrah

al-Mā'idah: *Your protector is only Allah, His Messenger, and those who believe. They are those who pray and give zakat while bowing down.*

Classical exegeses explicitly state that this āyah particularly refers to the virtue of Imam 'Alī (ع). Fuzuli's allusion to this event in his bayt confirms Imam 'Alī (ع)'s high position in Islamic society.

As well as being a poet of religious devotion, Fuzuli is also a lyrical poet. In his longest qasīda, the lyrical persona experiences profound emotional turmoil in pursuit of love, undergoing pain and longing while maintaining purity and virtue:

ظواهرُ حالي في الملام علامةً ولكنَّ حالي في الضمير سوى الصفا

(Bandaroghlu, 1994, p. 73)

*My outward appearance indicates blame,
yet in my inner being, there is nothing but purity.*

Some of the poet's couplets can be compared both to the Emevi period's platonic love-exalting *udhri poetry* and to the Abbasid period's *aff poetry*, which occupies an intermediate position between *udhri poetry* and explicit ghazals. Such poems typically begin with complaints to Allah, accompanied by tears, anguish and sorrow, as well as feelings of longing, reunion, sorrow and joy, and complaint and contentment. These characteristics are also evident in Fuzuli's ghazals. However, the philosophical content typical of Fuzuli's ghazals is not characteristic of Arabic ghazals, which have a simpler effect. In other words, the love conveyed in Fuzuli's works can only be compared to that sung by poets of pure, chaste love due to its purity and innocence. Unlike Arab poets, Fuzuli's love evolves and carries philosophical meaning.

Conclusion: Thus, the 465 surviving Arabic bayts of Fuzuli allow modern scholars to appreciate a distinct facet of his literary genius. Fuzuli's Arabic qasīdas represent a distinct and integral component of his literary corpus. Despite their relatively small number compared to his Turkish and Persian works, they demonstrate mastery of classical Arabic meters, rhetorical devices, and semantic subtleties. Reflecting both spiritual devotion to Imam 'Alī (ع) and the Prophet Muhammad (ﷺ) and lyrical explorations of earthly love, the qasīdas combine Sufi and ethical reflections with the artistic rigour of classical Arabic poetry. Therefore, these qasīdas should be studied alongside his Turkish and Persian poetry to gain a comprehensive understanding of Fuzuli's poetic genius and his contribution to the literary traditions of the Islamic world.

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DIDACTIC OPPORTUNITIES FOR DEVELOPING ENGLISH ORAL SPEECH IN THE MONTESSORI LEARNING ENVIRONMENT

Abstract

This article examines the didactic possibilities of developing oral speech in English within the Montessori learning environment. In early childhood education, the formation of communicative competence in a foreign language depends not only on the introduction of vocabulary and language structures, but also on the learning conditions that support natural language acquisition and active communication. The Montessori educational environment, based on the principles of independence, prepared environment, and sensory-based learning, creates favorable conditions for the development of children's oral speech skills. The study analyzes how Montessori materials, interactive activities, and child-centered teaching approaches contribute to the formation of English speaking skills in preschool children. The article also highlights the role of communicative tasks, visual materials, and practical activities in stimulating children's motivation to speak and express their ideas in English. The findings demonstrate that the integration of Montessori pedagogical principles with foreign language instruction can effectively support the development of oral communication skills and enhance language learning outcomes in early childhood education.

Keywords: *montessori learning environment, oral speech development, English language teaching, preschool education, communicative competence, Montessori pedagogy*

Introduction

In the 21st century, the role of early childhood education has become increasingly important, as modern educational systems emphasize the development of communicative competence, creativity, and independent thinking from the earliest stages of learning. In this context, foreign language education, particularly English language learning, begins during preschool years when children possess strong cognitive flexibility and natural language acquisition abilities. Therefore, the formation of oral speech skills in English at the preschool level has become one of the significant tasks of contemporary pedagogy. [1]

The effectiveness of foreign language learning in early childhood largely depends on the learning environment and teaching approaches used in the educational process. Among the innovative pedagogical approaches, the Montessori method has gained considerable recognition due to its child-centered philosophy and emphasis on natural learning. The Montessori educational environment is designed to support children's independence, curiosity, and active participation in learning activities. Through carefully prepared materials and structured learning spaces, children are encouraged to explore language through observation, interaction, and practical experience. [2]

Maria Montessori emphasized that early childhood is characterized by sensitive periods during which children demonstrate heightened receptivity to language acquisition. According to Montessori, children absorb language naturally from their surrounding environment through listening, imitation, and interaction with others. This concept is closely related to the idea of the "absorbent mind," which explains how young children internalize linguistic structures without conscious effort. As a result, the Montessori environment provides favorable conditions for developing oral communication skills in a foreign language. [3]

In the context of English language learning, Montessori-based activities such as storytelling, role-play, conversation practice, and the use of visual and sensory materials can significantly contribute to the development of children's speaking abilities. These activities create authentic communicative situations that encourage children to express their ideas, describe objects, ask questions, and participate in simple dialogues. Consequently, the Montessori learning environment offers significant didactic opportunities for fostering oral speech development and enhancing children's communicative competence in English during the preschool stage. [4]

Literature Review

Maria Montessori's educational theory provides one of the most influential frameworks for early childhood education and language development. Montessori emphasized that young children possess what she called the "absorbent mind," a unique mental capacity that allows them to naturally absorb information from their environment without conscious effort. According to Montessori, children between the ages of 3 and 6 experience a *sensitive period for language*, during which they can acquire vocabulary, pronunciation, and communicative patterns through interaction, observation, and imitation. This concept highlights the importance of creating a language-rich environment where children can naturally develop oral speech skills. [5]

Montessori also introduced the idea of the *prepared environment*, which plays a central role in supporting children's cognitive and linguistic development. In such an environment, educational materials, objects, and learning spaces are carefully organized to encourage independent exploration and communication. Through the use of visual materials, real objects, and structured activities, children are provided with opportunities to listen, repeat, and gradually use new

words and expressions in meaningful contexts. This approach enables language learning to occur naturally through daily activities and interaction.

Research on early language acquisition also supports Montessori's perspective. Scholars such as Stephen Krashen emphasize the role of meaningful communication and comprehensible input in language learning. Krashen's input hypothesis suggests that children acquire language most effectively when they are exposed to understandable language in natural situations. In Montessori classrooms, storytelling, conversation activities, and interactive tasks provide rich linguistic input that encourages children to develop their speaking skills. [6]

In addition, Lev Vygotsky's sociocultural theory highlights the importance of social interaction in language development. Vygotsky argued that children learn language through communication with more knowledgeable individuals such as teachers and peers. Montessori learning environments promote collaborative activities and guided interaction, which support the development of children's oral communication abilities. [7]

Methodology

The research adopts a theoretical-analytical approach combining several pedagogical and psychological frameworks, including:

- Montessori's theory of early childhood education and the absorbent mind
- the concept of the prepared learning environment in Montessori pedagogy
- communicative language teaching principles for developing speaking skills
- sociocultural learning theory emphasizing interaction and collaboration

Based on these theoretical foundations, the study analyzes the didactic possibilities of the Montessori learning environment for developing oral speech in English among preschool children. The proposed approach demonstrates how Montessori materials, communicative activities, and child-centered learning strategies can effectively support the development of young learners' speaking abilities.

Results

Based on the analysis of international and national practices in early childhood education, a didactic model for developing English oral speech in the Montessori learning environment was developed. The model aims to support natural language acquisition, encourage communicative interaction, and integrate Montessori pedagogical principles into early foreign language learning.

The proposed model includes three integrated components:

1. Cognitive Component

This component focuses on the formation of basic English language knowledge among preschool children. At this stage, learners acquire new vocabulary, simple expressions, and pronunciation patterns through visual materials, real objects, picture cards, and sensory-based Montessori materials. Language learning occurs through listening, observation, and repetition in meaningful contexts.

2. Operational Component

This component emphasizes practical communicative activities that support the development of speaking skills. Activities such as role-playing, storytelling, dialogue practice, and object description encourage children to actively use English in simple communicative situations. Montessori materials and hands-on activities promote independent participation and support the development of oral communication.

3. Motivational-Communicative Component

This component focuses on developing children's motivation and interest in speaking English. The supportive and child-centered Montessori environment allows children to express their ideas freely and participate in interactive activities. Teachers act as facilitators who guide communication and encourage children to engage in verbal interaction.

The model is implemented through four stages:

Stage 1: Language Environment Preparation: Children are introduced to basic English vocabulary and expressions through visual materials, songs, pictures, and real objects. This stage creates a language-rich environment that stimulates curiosity and interest.

Stage 2: Active Communicative Practice: Children participate in communicative activities such as role-play, simple dialogues, storytelling, and question-answer tasks. These activities provide opportunities for meaningful language use.

Stage 3: Speech Reinforcement: Previously learned vocabulary and expressions are reinforced through interactive games, group activities, and repeated communicative practice. This stage helps consolidate children's speaking skills.

Stage 4: Free Communication Development: Children gradually begin to express their thoughts more independently through short conversations, descriptions, and storytelling activities. The Montessori environment supports natural communication and the further development of oral speech.

As a result, the integration of Montessori pedagogical principles with English language instruction provides effective didactic opportunities for developing oral speech skills and enhancing communicative competence among preschool children.

Discussion

The findings of this study support the growing recognition in early childhood education that the development of oral communication skills in a foreign language should begin at an early age and be supported by an appropriate pedagogical environment. The Montessori learning environment demonstrates that when language learning is integrated into children's natural activities rather than introduced as a formal instructional subject, it becomes a meaningful and effective process. In this sense, the Montessori approach provides significant didactic opportunities for transforming everyday interaction into a natural context for language development.

One of the key contributions of this approach lies in the integration of Montessori pedagogical principles with foreign language teaching. Montessori emphasized the importance of the prepared environment, independence, and sensory learning as the foundation of

children's cognitive development. [8] Within such an environment, language learning occurs through observation, imitation, and communication with peers and teachers. These principles create conditions where children acquire English vocabulary and speaking patterns naturally through meaningful experiences rather than through memorization of isolated linguistic forms.

The concept of the "absorbent mind," introduced by Maria Montessori, plays a crucial role in explaining how young children acquire language. [9] According to this concept, children between the ages of three and six have a unique capacity to absorb linguistic structures from their environment without conscious effort. When children are placed in a language-rich Montessori environment, they are constantly exposed to English words, expressions, and communicative patterns through songs, stories, conversations, and practical activities. This exposure significantly contributes to the development of their oral speech skills. [10]

Another important aspect highlighted in this study is the role of sensory and practical learning materials in language development. [11] Montessori materials encourage children to interact with objects, pictures, and symbols that represent real-world concepts. Such interaction not only enhances cognitive understanding but also stimulates verbal expression, as children naturally describe objects, ask questions, and respond to communicative prompts during activities.

In addition, communicative interaction plays a central role in developing oral speech within the Montessori environment. Activities such as storytelling, role-playing, dialogue practice, and collaborative tasks provide opportunities for children to use English in authentic communicative situations. These activities help children gradually build confidence in speaking and develop the ability to express their ideas in simple but meaningful ways. [12]

An important contribution of the proposed approach is the emphasis on child-centered learning. Unlike traditional language instruction that often relies on teacher-led explanations, the Montessori method encourages children to actively explore language through independent and cooperative activities. In this process, the teacher acts primarily as a facilitator who guides communication, supports interaction, and creates opportunities for meaningful language use. [13]

Another significant advantage of the Montessori approach is its ability to maintain children's motivation and curiosity. Because activities are designed to be engaging and interactive, children participate willingly in communication and language-related tasks. This motivational dimension is particularly important in preschool education, where positive emotional experiences strongly influence the effectiveness of learning. [14]

Finally, the results of the study demonstrate that integrating Montessori pedagogical principles into early foreign language instruction creates a supportive and effective framework for developing oral communication skills. By combining a prepared learning environment, communicative activities, sensory materials, and child-centered interaction, the Montessori ap-

proach contributes to the successful formation of English oral speech skills among preschool children and supports the development of their overall communicative competence.

Conclusion

This study demonstrates that the Montessori learning environment provides significant didactic opportunities for developing oral speech in English among preschool children when foreign language learning is organized as a natural and communicative process. The integration of Montessori pedagogical principles with early language education creates favorable conditions for children to acquire vocabulary, pronunciation, and basic communicative structures through meaningful interaction and practical activities.

The proposed approach emphasizes the combination of cognitive, communicative, and motivational components, ensuring that language learning moves beyond simple memorization of words toward the development of active speaking skills and communicative competence. In this context, Montessori materials, visual aids, and hands-on activities help children associate language with real-life experiences, which strengthens both understanding and verbal expression.

The implementation of the four-stage developmental model supports the gradual formation of oral speech skills. Through language environment preparation, communicative practice, reinforcement activities, and free communication development, children progressively move from passive listening to active participation in simple English conversations. This staged approach allows young learners to build confidence and develop speaking abilities in a supportive and engaging learning environment.

Furthermore, the Montessori method encourages independence, curiosity, and intrinsic motivation, which are essential factors in early language learning. The child-centered nature of Montessori education allows children to explore language at their own pace while interacting with peers and teachers in meaningful communicative situations.

Overall, the integration of Montessori pedagogy into early English language instruction contributes to the effective formation of oral communication skills and supports the development of communicative competence in preschool children. Future research may focus on empirical investigation of Montessori-based language learning models and the development of innovative teaching materials that further enhance oral speech development in early childhood education.

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THE FIGURATIVE FORM, COMPOSITION, AND LANGUAGE OF THE POETRY OF BYRON

Abstract:

In this article illustrates the figurative form, compositional structure, and linguistic features of the poetry of Lord Byron within the broader framework of English Romanticism. The study argues that Byron's poetic system is characterized by a dynamic interaction between symbolic representation, structural experimentation, and rhetorical versatility. Particular attention is given to the function of the Byronic hero as a metaphorical construct that embodies modern subjectivity, alienation, and moral ambivalence. The analysis further explores Byron's innovative use of hybrid genres, narrative digression, and stanzaic form—especially in Childe Harold's Pilgrimage, Manfred, and Don Juan—demonstrating how compositional flexibility reinforces thematic complexity.

Keywords: Lord Byron; English Romanticism; figurative language; metaphor; symbolism; Byronic hero; poetic composition; narrative structure; ottava rima; irony; poetic diction; Romantic aesthetics; satirical epic; literary style.

Introduction: George Gordon, Lord Byron (1788–1824), stands as one of the central figures of English Romanticism. His poetry is distinguished by its powerful figurative structures, innovative compositional strategies, and a linguistic style that combines emotional intensity with rhetorical control. Byron's poetic art reflects both Romantic subjectivity and a critical, often ironic awareness of literary tradition. This article examines the metaphorical (figurative) form, compositional design, and linguistic features of Byron's major poetic works, demonstrating how these elements interact to produce a distinctive poetic voice.

The poetry of George Gordon, Lord Byron, is a cornerstone of the Romantic movement, characterized by a synthesis of intense emotionality, satirical wit, and a mastery of traditional poetic forms. While aligning with Romanticism's focus on individual emotion and nature, Byron uniquely blended this with an 18th-century rhetorical style to create a distinctive, often rebellious, voice. It is well known that no writer develops in complete isolation from literary tradition. Every creative figure, consciously or unconsciously, engages with the aesthetic heritage of the past. However, only those authors who fail to establish an individual style merely reproduce earlier models without critical transformation or innovation. In literary analysis, therefore, the question of tradition is often primary: only by comparing new works with their predecessors, and by identifying which artistic devices have been assimilated and reinterpreted, can we properly evaluate a writer's stylistic originality and artistic mastery. In many cases, a careful study of figurative techniques reveals that an author surpasses earlier writers through a more refined and powerful use of imagery.

In the poetry of Lord Byron, personification, metaphor, and simile occupy a particularly prominent place. Personification, in particular, had developed significantly by the eighteenth century in the works of English classical writers. For neoclassical poets, personification frequently served to elevate style, lending grandeur and rhetorical dignity to poetic expression.

Byron likewise makes extensive and purposeful use of personification. In his poetry, however, this device functions not merely as ornamentation but as a

powerful means of generalization and exposure. In the poem commonly referred to as *English Bards and Scotch Reviewers*, he exposes a moral corruption that dominates English society and calls upon satire to confront and condemn it. It is widely acknowledged that those who disregard the law often fear public ridicule more than legal punishment; the power of laughter and mockery can restrain where formal authority fails.

This idea is vividly expressed in the following lines:

When Vice triumphant holds her sov'reign sway,
Obey'd by all who nought beside obey;
When Folly, frequent harbinger of crime,
Badecks her cap with bells of every Clime;
When knaves and fools combined o'er all prevail,
And weigh their Justice in a Golden Scale;
E'en then the boldest start from public sneers,
Afraid of Shame, unknown to other fears,
More darkly sin, by Satire kept in awe,
And shrink from Ridicule, though not from Law.
Are there no sins for Satire's Bard to greet?
Stalks not gigantic Vice in every street?
Shall Peers or Princes tread pollution's path, —
And 'scape alike the Laws and Muse's wrath?

In these lines, personification and metaphor serve primarily to intensify and universalize the poet's argument. Expressions such as "Vice triumphant holds her sov'reign sway" and "Stalks not gigantic Vice in every street?" transform abstract moral categories into active, almost tyrannical forces. Vice is not a passive concept but a sovereign ruler; it "holds sway" and "stalks" the streets like a living being. Through such imagery, Byron converts ethical abstraction into dramatic presence.

The metaphor "pollution's path" further strengthens the denunciatory tone. The word *pollution* conveys a heightened sense of moral contamination, suggesting not merely error but corruption of the deepest kind. At the same time, Byron employs lexemes charged with intensity—*wrath*, *shrink*, *sneers*—which denote decisive action and sharp emotional force. As a result, these partially personified lines embody an atmosphere of anger and indignation. The emotional density of the language reinforces the satirical thrust and heightens its expressive power.

Byron frequently enriches his personifications through the use of mythological names. In his lyric poetry, mythological figures are not static allegorical symbols but living embodiments of abstract ideas. Through poetic animation, they acquire personality, emotional depth, and strength of will. Byron endows ancient gods and mythological beings with human qualities, transforming them into contemporaries of the reader and representatives of Romantic ideals.

In the poem *Prometheus* (1816), for example, the Titan is presented not merely as a mythological character but as a living symbol of human resistance. Byron addresses him directly:

“Titan! to whose immortal eyes
The sufferings of mortality,
Seen in their sad reality,
Were not as things that gods despise.”
Here Prometheus is not an indifferent deity; he
perceives human suffering and responds to it with
compassion. His torment is depicted as an active and
conscious condition:
“A silent suffering, and intense;
The rock, the vulture, and the chain,
All that the proud can feel of pain.”
Prometheus’ silence is not passivity but deliberate
endurance:
“Which speaks but in its loneliness,
And then is jealous lest the sky
Should have a listener.”

Byron portrays him as a living being who guards his sorrow jealously, as though afraid that even the heavens might overhear it. In this way, myth is transformed into psychological drama, and personification becomes a vehicle for expressing Romantic ideals of defiance, dignity, and moral steadfastness.

One of the significant manifestations of personification is expressed in the direct address to inanimate objects or abstract concepts. In such instances, lifeless entities and intangible notions are endowed with seemingly human capacities, as if they were able to hear the poet’s words and respond to them. In *Childe Harold’s Pilgrimage*, Byron addresses elements of nature: “Sky – Mountains – River – Winds – Lake – Lightnings! Ye!” (III, 96). He also turns to abstract concepts, such as Love: “Oh, Love! no habitant of earth thou art...” (IV, 121), and Time:

Oh Time! The Beautifier of the dead,
Adorner of the ruin – Comforter
And only Healer when the heart hath bled –
Time! The Corrector where our judgments err,
The test of Truth, Love – sole Philosopher,
For all beside are sophists...
Time, the Avenger! Unto thee I lift
My hands, and eyes, and heart, and crave of thee a gift
(IV, 130)

This stylistic device corresponded fully to the conventions of classical poetry. It is sufficient to recall that classical poets traditionally invoked the Muse before beginning their works. According to classical aesthetics, such appeals conferred elevation and grandeur upon the poem and fulfilled the expectations of ancient literary tradition. In Byron’s lyric poetry, similar addresses likewise intensify the sense of sublimity. At the

same time, however, these invocations acquire a distinctly emotional character. Byron describes Time as a consoler, a comforter, a healer of wounded hearts, a corrector of mistaken judgments, the criterion of Truth and Love, a supreme philosopher, and ultimately an avenger.

Byron frequently resorts to such stylistic devices when a particular impression evokes in him powerful emotional responses. A notable example is his admiration when contemplating Italian cities and their ancient monuments. Describing Venice, the vibrant city of the Renaissance, he calls it “the pleasant place of all festivity,” “the Revel of the earth,” and “the Masque of Italy”:

Nor yet forget how Venice once was dear,
The pleasant place of all festivity,
The Revel of the earth – the Masque of Italy! (Ch. H.
IV, 3)

Similarly, in *Childe Harold’s Pilgrimage*, Byron dedicates a separate stanza to the Roman Pantheon, characterizing it as the “shrine of all saints and temple of all Gods,” the sanctuary of Art and Piety, and the pride of Rome:

Simple, erect, severe, austere, sublime –
Shrine of all saints and temple of all Gods,
From Jove to Jesus – spared and blest by Time –
Looking tranquillity, while falls or nods
Arch – empire – each thing round thee – and Man
plods

His way through thorns to ashes – glorious Dome!
Shalt thou not last? Time’s scythe and Tyrants’ rods
Shiver upon thee – sanctuary and home
Of Art and Piety – Pantheon! – pride of Rome! (IV,
146)

The conclusion of the stanza may also be interpreted as a periphrastic address. In general, periphrasis was highly developed in the style of classical writers. It enabled poets to avoid what were considered “low” or prosaic words. Within the conventional poetic diction of classicism, expressions such as “fleecey breed” replaced the word “sheep,” “beauteous kind” denoted women, and a shepherd’s duties were referred to as “rural care.” Alexander Pope, in *The Rape of the Lock*, famously designated “scissors” through the periphrastic expression “the double-edged engine.”

Byron, however, did not face the same aesthetic constraints. By the end of the eighteenth century, writers—particularly Wordsworth and his successors—had already begun to challenge the rigid norms of classical aesthetics, including the avoidance of direct naming. For Byron, periphrasis functioned primarily as a lyrical device rather than as a formal requirement. It allowed him to illuminate the depicted object from multiple perspectives and to convey the complex impressions and emotions it awakened within him.

Thus, while periphrasis originated as a stylistic device sanctioned by classical tradition, in Byron’s poetry it acquires new semantic depth and expressive purpose. Instead of merely elevating diction, it becomes a means of emotional intensification and multifaceted representation, reflecting both continuity with tradition and creative transformation within the framework of Romantic poetics.

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