ПЕДАГОГИКА ЖӘНЕ ГУМАНИТАРЛЫҚ ҒЫЛЫМДАР ФАКУЛЬТЕТІ

"ИННОВАЦИЯЛЫҚ АҚЫЛ-ОЙ: БОЛАШАҚТЫ STEM САЛАСЫНДАҒЫ БІЛІМ БЕРУ АРҚЫЛЫ ҚАЛЫПТАСТЫРУ" АТТЫ I ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ-ПРАКТИКАЛЫҚ КОНФЕРЕНЦИЯНЫҢ (IMSF) МАТЕРИАЛДАРЫ

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BREAKING BARRIERS: INTEGRATING INCLUSIVE PRACTICES IN CHEMISTRY EDUCATION

Abstract. This article examines the issues of inclusive pedagogy in the field of chemistry. It analyzes the barriers faced by students with disabilities in the process of learning chemistry and proposes methods for integrating inclusive practices into the educational process. The paper discusses the importance of creating an accessible and supportive environment for all students and considers practical examples of successful implementation of inclusive approaches in teaching chemistry.

Keywords: inclusive education, chemistry, pedagogy, accessibility, students with disabilities.

Introduction

The process of acquiring the knowledge, abilities, and positive attitudes necessary for a fulfilling existence is called education, and it takes a lifetime. This ought to be, regardless of the limitations exhibited by the special needs children protected under the Inclusive Education Policy (IEP). Every school was required by the inclusive education policy to treat every student equally in the classroom and at school. This rule cannot be ignored in chemistry lessons.

In the current educational environment, the idea of inclusion has grown in significance. It comprises setting up a setting where all students have an equal chance to learn and achieve, regardless of their background, skills, or limitations. This idea applies to all academic fields, including chemistry, where implementing inclusive practices is essential to creating a welcoming and inclusive learning environment.

Practical work in the lab is an obligatory component of most medical and chemical courses, including pharmacy and pharmaceutical sciences, in order for students to receive their degree. Theoretical or online instruction cannot replace this work. Despite the physical accessibility of the site and the requirement for manual manipulation of equipment, practical lessons regrettably present several challenges for students with disabilities. Students must read and listen quickly in hands-on learning environments, retain information and take brief notes, use time management skills, and make a range of quick decisions. Any of these might be challenging for students with impairments.

Literature review

The article “From barriers to boosters: initial teacher education for inclusive education” by Silvia Frankel, Moritz Sterken, Lisa Stinken-Rosner (2023) presents The viewpoints of inclusive pedagogy and scientific education must be integrated in order to achieve effective and inclusive science education (ISE) (Stinken-Rösner et al., 2020). This calls for the meticulous formulation and differentiation of inclusive pedagogical elements in science education, which places particular requirements on science teachers. It is imperative that they have the requisite knowledge and abilities to integrate science-specific content with inclusive teaching approaches. The authors highlighted that, to do this, though, a few obstacles in teacher education must be removed. Firstly, opinions on what should be covered in science teacher education and professional development programs for inclusion are divided. It is essential to create an

open and clear understanding of what ISE should entail in order to advance the foundation of best practices. Second, there are structural obstacles that make it challenging to integrate the elements of subject-specific knowledge and IE, such as the different study plans for regular and special education teachers. Thirdly, as a result, prospective teachers' teacher education seldom incorporates blended techniques. They emphasized capabilities like identifying and assessing learning deficits, differentiating instruction, or individualizing instruction are seldom ever included in science teacher education.

The article “Teaching energy in living systems to a blind student in an inclusive classroom environment” by Dilek Teke, Mustafa Sozbilir (2019) shows that it is crucial to change educational environments based on the needs of students with disabilities. The authors present two methods to education: offering special education classes to learners who need them apart from their peers and educating them in inclusive classrooms. Students with special needs are integrated into general education courses in inclusion classes, which have grown increasingly common in recent years. However, integrated education is the act of removing obstacles from learning environments in order to boost student engagement and lesson discrimination in the classroom. In actuality, integrated education refers to a broad range of methods, initiatives, and procedures meant to fulfill everyone's right to receive education. Integration is a right to education for all children who are disadvantaged for various reasons, even though it is strongly linked to the right of children with disabilities to an education.

The authors highlighted that for those who have low vision or are blind, understanding chemistry is crucial to their everyday existence. There is still a dearth of research, although recent efforts to eliminate barriers and make chemistry more accessible for these students have focused on conceptual comprehension studies and teaching symbolic representations in chemistry. The majority of research has concentrated on creating accessible laboratory settings, modifying current technologies to make chemistry more approachable, and using conceptual knowledge to teach symbolic representations in chemistry.

Based on the research BLV pupils have low interest in science and mathematics because of the barriers in school learning spaces. Three categories can be used to categorize barriers to science access. They are: (i) insufficient teacher preparation; (ii) restricted access to resources and tools; and (iii) educators' acceptance.

The article "Teaching Chemistry to Students with Disabilities: A Manual for High Schools, Colleges, and Graduate Programs 4th Edition." (2001) by Miner, Dorothy L discusses mentoring pupils with impairments similar to mentoring other students to mentor a kid with a disability. Teachers and mentors need to be aware that people with impairments may have low expectations and low self-esteem. Activities that take place outside of the classroom allow students to recognize, use, and record their special talents. Typically, their strong points include their capacity for problem-solving, tenacity, familiarity with negotiation techniques, and ability to forge agreement. Teachers and mentors should encourage students with disabilities to engage in extracurricular activities.

These include: undergraduate research projects; campus organizations or interest groups that cater to the needs of students with disabilities; membership in scientific societies, such as the ACS Student Affiliates program; work-based learning opportunities;

In the article, it is written that some learning-disabled students perform better in the lab than in the classroom. This is largely due to the lab's multimodal training, which blends written content from the lab manual and notebook, hands-on exercises, and verbal presentations from the teacher. Depending on

the nature of a given lab exercise, adjustments in the lab may be necessary for some students. Students who suffer from impairments related to auditory processing or sequencing, for instance, could find it challenging to follow detailed instructions unless they are accompanied by written instructions.

For instance, investigation based learning laboratory exercises are more beneficial to all students than activities or demonstrations with preset results. As a result, laboratory exercises can be changed such that students must come up with their own methods for answering a particular subject.

The article “Three steps for gaining access to the general education curriculum for learners with disabilities” by King-Sears, Margaret E. offers three steps to assist teachers in assessing how accessible their general education curriculum is for students with disabilities. There are also recommendations for improving the curriculum and thinking of original ways to change it. In addition to improving learning for students with mild to moderate disabilities as well as typical students and students at risk of failing their classes, special educators who use this process and work with general educators to improve weak curriculum attributes also reap two main benefits: Students with mild to moderate disabilities, typical students, and students at risk of failing school all benefit from (a) improved learning and (b) more methodical, individualized placement decisions for students with disabilities, which may lead to the least restrictive environment being the general education setting.

The article "Inclusion by design: Embedding inclusive teaching practice into design and preparation of laboratory classes." Hackl, Ellen, and Irina Ermolina present that Higher education providers are responsible for providing individual adjustments and for creating an inclusive learning environment. Numerous assessments from the past few years have concentrated on the institutional commitment to inclusive teaching and learning as well as the development, implementation, and evaluation of inclusive curricula. But, particularly in lab settings, inclusive learning environments aren't frequently integrated into the broader requirements of the university. The majority of science and medical courses, including pharmacy and pharmaceutical sciences, require students to complete practical work in the lab as a required component of their education. This work cannot be substituted with theoretical or online instruction.

The article "Inclusion in chemistry education in secondary school." (2018) by Michna, Dagmar, and Insa Melle discuss that as an evidence-based strategy to make schools and learning accessible for all learners, the Universal creation for Learning (UDL) framework has been developed in the US for the creation of inclusive learning environments. The main thesis is that universal access to the learning materials may be necessary for effective learning for all pupils. To be more specific, the UDL framework is made up of teaching strategies that allow students options and choices with regard to the resources, settings, subjects, etc. A productive learning environment reduces obstacles while providing students with support and challenge. The autors belief that flexible teaching strategies and resources are necessary to minimize barriers. And as a result, according to CAST (2011), the UDL framework has three main principles:

Principle I: Provide Various Representation Methods (the "what" of education)"

Principle II: Provide Multiple Means of Action and Expression (the “how” of learning)

Principle III: Provide Multiple Means of Engagement (the “why” of learning)”

The purpose of this research is to determine the topics mentioned in order to integrate science-specific content with inclusive teaching approaches. The research question is How significant topics are found out to integrate subject content with inclusive teaching approaches.

Methodology

A comprehensive review of more than 20 academic articles fulfilling the frameworks or principles of the Integrative content and inclusive teaching for the study of chemistry was carried out, 9 of which were analyzed, special attention was paid to aspects of the structure of the Integration for the school in Chemistry Lessons. Working with keywords such as "inclusive practices in chemistry teaching" made it possible to identify relevant research and articles for inclusion in the analysis. The study of articles and their comparison made it possible to identify the main frameworks and principles of the methods of implementing the Integrative inclusive teaching for school used in the context of teaching chemistry.

Sampling

In order to accomplish the goal, we examined 9 scientific publications, including methodological books, essays, and scientific journals.

Article name (author, year of publication)	Description
"From barriers to boosters initial teacher education for inclusive science education"Frankel,Silvia (2023)	Offers informative analysis and suggestions for improving initial science teacher education programs in the context of inclusion. Discusses current obstacles and supporters in the context of initial science teacher education for inclusion.
"Teaching energy in living systems to a blind student in an inclusive classroom environment."Teke Dilek and Mustafa Sozbilir (2019)	Adapting learning settings to the requirements of students with impairments is crucial. The authors provide two approaches to education: educating students in inclusive classrooms and providing special education programs to those who require them separately from their peers.
"Teaching chemistry to students with disabilities: A manual for high schools,colleges,and graduate programs 4th edition" Miner,Dorothy L (2001)	Ways of teaching chemistry to students with disabilities. Recommended to encourage students with disabilities to engage in extracurricular activities.
"Three steps for gaining access to the general education curriculum for learners with disabilities" King-Sears, Margaret E (2002)	provides instructors with three steps to help them determine whether their general education curriculum is accessible to students with disabilities. Additionally, suggestions for enhancing the curriculum and coming up with novel modifications are included.

"Inclusion by design:Embedding inclusive teaching practice into design and preparation of laboratory classes" Hacki,Ellen and Irina Emollina (2019)	For learners with disabilities, lab lessons can pose numerous challenges. Making proactive changes to the planning and organization of laboratory classes can help to ensure that lab-based learning is as inclusive and accessible as feasible.
"Inclusion in chemistry education in secondary school" Michna, Dagmar and Insa Melle (2018)	Explore examples, principles to integrate science-specific content with inclusive teaching approaches. A conducive learning environment lessens barriers while offering students challenge and support.
"The future of laboratory chemistry learning and teaching must be accessible" Egambaram,Orielia (2022)	About making laboratory-based chemistry learning environments, teaching, assessment, and resources accessible to all students and staff.
"An exploratory study of universal design for teaching chemistry to students with and without disabilities" King-Sears,Margaret E (2015)	Conducted a survey between students with and without disabilities while teaching chemistry. For the post-tests, there was an interaction effect between students with and without disabilities, but there were no significant differences between the conditions.
"Conflicting demands of Chemistry and Inclusive Teaching" Abel Simone,Brigitte Koliander and Thomas Plotz(2020)	Examines the problems that a teacher may encounter when instructing a so-called "hard science," such as chemistry, in an inclusive classroom. It is believed that all students should be able to participate in science-specific learning processes thanks to inclusive science education.

Data collection

During my research work, I searched for articles on the topic "**INTEGRATING INCLUSIVE PRACTICES IN CHEMISTRY EDUCATION**" in Google Scholar, especially paying attention to the keywords about topic related to inclusive practices in chemistry education. I studied various academic databases to find relevant literature and critically evaluated the ways in which each article addressed the research objectives. This process helped to ensure that relevant and high-quality articles were included in the analysis on the topic.

Data analysis

After carefully examining each article, I discovered that nine of them fully addressed the study's frameworks and principles and provided insightful details about the usefulness and real-world applications of inclusive teaching and learning when implementing the integrated subject content and inclusive pedagogy in the chemistry classroom.

Result

Article name	Related topic	Frequency	Percentage
Frankel et al. (2023) Kings-Sears,Margaret E et al.(2015)	The add-on approach and subject-specific elaboration	2	22.2%
Michna, Dagmar, and Insa Melle (2018) Teke Dilek and Mustafa Sozbilir (2019) Miner, Dorothy L et al(2001)	Design of Inclusive classrooms	3	33.3%
Abele Simone,Brigitte Koliander et al. (2020)	Documentary method	1	11.1%
Frankel et al. (2023) Hacki, Ellen and Irina Emollina (2019) Egambaram, Orielia (2022) Miner, Dorothy L et al (2001)	open educational resources	4	44.4%
Kings-Sears, Margaret E et al. (2015) Frankel et al. (2023)	Universal Design for Learning (UDL)	2	22.2%

At the end of the study, 9 different articles on "inclusive practices in chemistry teaching" were analyzed, identifying five types of topics. The main topics include the importance of creating a supportive and accessible learning environment for all students, regardless of their backgrounds or abilities (open educational resources)-44.4% and design of inclusive classrooms-33.3%.

Conclusion

In conclusion, the article explores the critical necessity of integrating inclusive approaches into chemistry education at its conclusion. After a thorough examination of the scholarly literature and a thorough analysis of pertinent studies, it is clear that creating an inclusive learning environment requires tackling the obstacles faced by students with disabilities. The research emphasizes the significance of developing welcoming and accommodating learning environments for all students by highlighting several frameworks and concepts for applying inclusive teaching approaches in chemistry classrooms.

The importance of proactive approaches, like using universal design for learning (UDL) principles, making use of free educational materials, and creating inclusive classrooms, is highlighted by key findings. These techniques seek to improve chemistry education equity, accommodate a range of learning demands, and increase student engagement. By using inclusive approaches, teachers may help all students succeed and make valuable contributions to the area of chemistry, which will improve learning outcomes for each student and the discipline as a whole.

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PISA ХАЛЫҚАРАЛЫҚ САЛЫСТЫРМАЛЫ ЗЕРТТЕУІ БАРЫСЫНДАҒЫ ҰСЫНЫЛҒАН ТАПСЫРМАЛАРДЫҢ СИПАТТАМАСЫ

Аңдатпа. Бұл мақала PISA халықаралық салыстырмалы зерттеуі шеңберіндегі математикалық есептерді талдауға арналған. Нақты өмірлік жағдайларда қолданылатын теориялық сұрақтар мен тапсырмалардың жиынтығынан тұратын математикалық есептердің әртүрлі түрлерін сипаттауға ерекше көңіл бөлінеді. Зерттеу барысында оқушылардың функционалдық сауаттылығын

бағалаудағы осы міндеттердің маңыздылығы атап өтіледі, бұл олардың математикалық білімдерін күнделікті өмірде қолдана білу қабілетін бағалауға көмектеседі.

Түйін сөздер: PISA, халықаралық салыстырмалы зерттеу, математикалық сауаттылық.

Кіріспе

2000 жылдан бастап, Экономикалық Ынтымақтастық және Даму Ұйымына (ЭЫДҰ) кіретін мемелекеттердің білім алушыларынан басталып қазіргі кезде әлемнің әр түкпіріндегі көптеген мемелекеттер мен жеке аймақтардың білім алушылары қатынасатын PISA халықаралық салыстырмалы зерттеуі халықаралық деңгейде танылған ықпалды бағалау құралы. Үш жылда бір рет өткізілінетін бұл зерттеу білім алушылардың біліктілігін үш бағыт бойынша, математикалық сауаттылық, жаратылыстану сауаттылығы және тіл сауаттылығы бойынша сараптайды. Әр салыстырмалы зерттеуде осы үш бағыттың біреуі басты бағыт ретінде таңдалады.

Қазақ Елі оқушылары бұл салыстырмалы зерттеуге 2009 жылдан бастап қатынасып келеді. Қазақ Елі оқушыларының бұл халықаралық салыстырмалы зерттеуде жоғарыда айтқан үш бағыт бойынша да және соның ішінде әсіресе математикалық сауаттылық бойынша нәтижелері «жақсы» деуге келмейді. Әрине мәселенің бұлай болуының көптеген себеп-салдарлары бар. Соның бірі, PISA халықаралық салыстырмалы зерттеуі барысында математикалық сауаттылық бойынша ұсынылатын тапсырмалардың сипатымен біздің жалпы білім беретін орта мектеп математика пәні мұғалімдерінің таныс болмауы дер едік. Осы жағдайға байланысты төменде әр жылдары PISA халықаралық салыстырмалы зерттеуі барысында келген, білім аушылардың математикалық сауаттылық деңгейін бағалауға арналған тапсырмаларды ұсынып отырмыз.

1-тапсырма. ПИЦЦА

Пиццерияда қалыңдығы бірдей және мөлшері әртүрлі екі дөңгелек пицца дайындалады. Кішісінің диаметрі 30 см және құны 30 зед. Үлкенінің диаметрі 40 см және құны 40 зед.

1-сұрақ: ПИЦЦА

Қай пиццаны сатып алу тиімдірек? Өз пікіріңізді дәлелдеңіз.

МӘСЕЛЕНІҢ МАҚСАТЫ:

Сипаттама: пиццаның мөлшері мен оның құны арасындағы байланысты орнату.

Математикалық мазмұн саласы: өзгеріс және тәуелділік

Контекст: жеке

Танымдық іс-әрекет: тұжырымдау

Жауап толығымен қабылданады

1: пиццаның беткі қабаты оның құнымен салыстырғанда тезірек өседі деген дәлел келтірілген, сондықтан үлкен пицца сатып алу тиімдірек

Пиццаның диаметрі оның құнына сәйкес келеді, бірақ пиццаның мөлшері оның ауданына байланысты, сондықтан сіз үлкен пицца сатып алғанда бір зедке көбірек пицца аласыз.

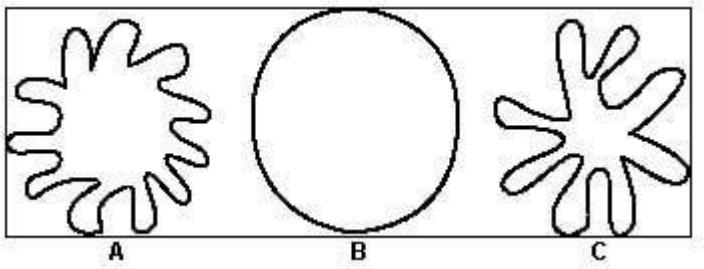
2: үлкен пицца тиімдірек деген қорытындыға келу үшін әр өлшем үшін бір зед үшін пиццаның ауданы мен саны есептелген.

Кішкентай пиццаның ауданы-0.25 x π x 30 x 30 = 225π; бір зедке арналған пиццаның мөлшері - 23.6 см2; үлкен пиццаның ауданы - 0.25 x π x 40 x 40 = 400π; бір зедке арналған пиццаның мөлшері-31.4 см2, сондықтан үлкен пицца тиімдірек.

Жауап қабылданбайды

1: олардың құны бірдей. (Бұл қате жауап бөлек шығарылды, өйткені біз қанша студенттің осылай жауап беретінін бақылағымыз келеді).
2: басқа жауаптар немесе дұрыс түсіндірусіз дұрыс жауап.
3: жауап жоқ.

2-тапсырма. ФИГУРАЛАР



1-Сұрақ: Фигуралар
Қай фигураның ауданы Үлкен? Шешіміңізді дәлелдеңіз.

Фигуралар: 1-сұрақтың жауабын бағалау

Сұрақтың мақсаты: дұрыс емес фигуралардың аудандарын салыстыру.

Жауап толығымен қабылданады

1: В фигурасы, қолайлы түсіндірмесі бар.
Бұл ең үлкен ауданы бар фигура, өйткені қалғандары оның ішіне сыйып кетуі мүмкін.

Жауап қабылданбайды

1: Қолайлы, бірақ дәлелсіз В фигурасы.
2: басқа жауаптар.
3: жауап жоқ.

3-тапсырма. ВАЛЮТА АЙЫРБАСТАУ БАҒАМЫ

Сингапурдан келген Мэй-Линг студенттермен алмасу бағдарламасы бойынша Оңтүстік Африкаға 3 айға сапарға дайындалды. Оған бірнеше Сингапур долларын (SGD) Оңтүстік Африка рэндіне (ZAR) ауыстыру қажет болды.

1-сұрақ: валюта айырбастау бағамы

Мэй-Линг Сингапур доллары мен Оңтүстік Африка рандының арасындағы айырбас бағамы келесідей екенін білді:
1 SGD = 4.2 ZAR
Мэй-Линг осы бағам бойынша Оңтүстік Африка рандасына 3000 Сингапур долларын айырбастады.
Мэй-Линг қанша оңтүстік африкалық ранд алды?
Жауап: 12 600 ZAR

ВАЛЮТА АЙЫРБАСТАУ БАҒАМЫ: 1-СҰРАҚҚА ЖАУАПТЫ БАҒАЛАУ

Жауап толығымен қабылданады

1: 12 600 ZAR (бірлік міндетті емес).

Жауап қабылданбайды

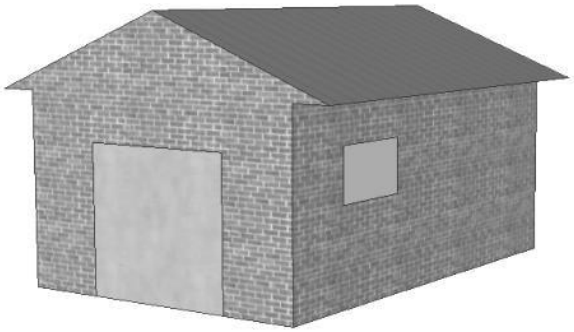
2: басқа жауаптар.

3: жауап жоқ.
2-сұрақ: валюта айырбастау бағамы
3 ай ішінде валюта айырбастау бағамы SGD үшін 4.2-ден 4.0 ZAR-ға өзгерді.4.2 ZAR орнына 4.0 ZAR-дағы жаңа мәміле Оңтүстік Африка рандтарын Сингапур долларына ауыстырған кезде Мэй-Линг үшін тиімді болды ма? Жауабыңызды түсіндіріңіз.
ВАЛЮТА АЙЫРБАСТАУ БАҒАМЫ: 3-СҰРАҚҚА ЖАУАПТЫ БАҒАЛАУ
Жауап толығымен қабылданады
1: қолайлы түсіндірмесі бар "Иә".
Иә, төменгі валюта бағамы бойынша (1 SGD үшін) Мэй-Линг оңтүстік африкалық рандтары үшін сингапурлық долларды көбірек алады.
Иә, бір долларға 4.2 ZAR бағамы бойынша ол 929 ZAR алады. [Ескерту: студент SGD орнына ZAR жазды, бірақ есептеу мен салыстыру нақты орындалды және бұл қатені ескермеуге болады.]
Иә, өйткені ол 1 SGD үшін 4.2 ZAR алды, ал қазір 1 SGD сатып алу үшін тек 4.0 ZAR қажет.
Иә, себебі 0.2 ZAR SGD сатып алу арзанға түсті.
Иә, өйткені 4.2-ге бөлінгенде, сома 4-ке бөлінгеннен аз болады.
Иә, курс тиімді болды, өйткені егер ол төмендемесе, ол 50 долларға аз алуы мүмкін еді.
Жауап қабылданбайды
1:" Иә", түсіндірусіз немесе жеткілікті дәл түсіндірмесіз.
Иә, төмен валюта бағамы тиімдірек болды.
Иә, курс тиімді болды, өйткені егер ZAR төмендесе, оның SGD-ге айырбастауға көп ақшасы болады.
Иә, Мэй-Линг үшін пайдалы болды.
2: басқа жауаптар.
3: жауап жоқ.
4-тапсырма. ФУДЗИ ТАУЫНА КӨТЕРІЛУ
Фудзи тауы – Жапониядағы әйгілі белсенді емес жанартау.
1-сұрақ: ФУДЗИ тауына көтерілу
Фудзи тауы жыл сайын 1 шілдеден 27 тамызға дейін адамдарды көтеру үшін ашық. Осы уақыт ішінде Фудзи тауына шамамен 200 000 адам көтеріледі.
Күніне Фудзи тауына орташа есеппен қанша адам көтеріледі?
A. 340
B. 710
C. 3400
D. 7100
E. 7400

ФУДЗИ ТАУЫНА КӨТЕРІЛУ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
МӘСЕЛЕНІҢ МАҚСАТЫ:
Сипаттама: Жалпы саны мен берілген кезеңді ескере отырып, адамдардың орташа күнделікті санын анықтаңыз.
Математикалық мазмұн саласы: Саны
Контекст: Қоғамдық
Танымдық іс-әрекет: тұжырымдау
Жауап толығымен қабылданады
1: C. 3400
Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ.

2-сұрақ: ФУДЗИ тауына көтерілу
Фудзи тауындағы Готемба жаяу жүргіншілер жолының ұзындығы шамамен 9 шақырымды құрайды.
Жаяу жүргіншілер 18 км серуеннен кейін 20 сағатқа оралуы керек.
Тоши тауға орташа жылдамдықпен 1,5 км/сағ көтеріліп, одан екі есе төмен түсе алады деп есептеді. Осы жылдамдықпен қозғалу кезінде тамақ ішуге және демалуға уақыт қалады.
Белгіленген жылдамдықтарды қолдана отырып Тоши, Тоши көтеріле бастайтын ең кеш уақытты анықтаңыз, сонда ол 20 сағатқа оралуы мүмкін.
Жауап: 11 (сағ)
ФУДЗИ ТАУЫНА КӨТЕРІЛУ: 2-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
МӘСЕЛЕНІҢ МАҚСАТЫ:
Сипаттама: екі жылдамдықты, жолдың жалпы ұзындығын және аяқталу уақытын ескере отырып, көтерілудің басталу уақытын есептеңіз.
Математикалық мазмұн саласы: өзгеріс және тәуелділік
Контекст: Қоғамдық
Танымдық іс-әрекет: тұжырымдау
Жауап толығымен қабылданады
1: 11 (сағ) [өлшем бірліктері көрсетілуі немесе көрсетілмеуі мүмкін. Мұндай уақытты жазуға да рұқсат етіледі-11:00.]
Жауап қабылданбайды:
1: басқа жауаптар.
2: жауап жоқ.

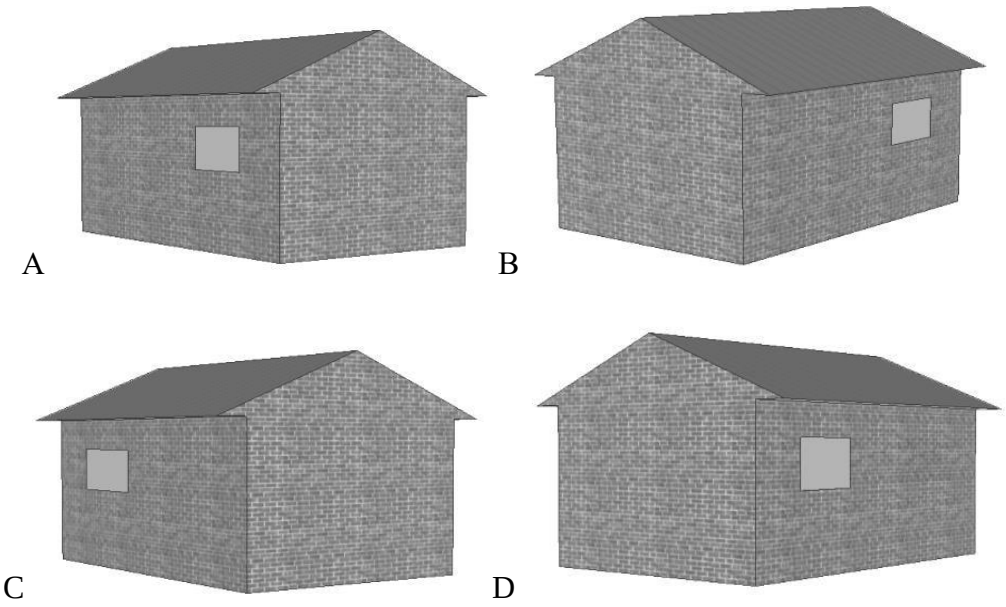
5-тапсырма. ГАРАЖ
Гараж өндірушісінің "негізгі" ассортименті тек бір терезесі мен бір есігі бар модельдерді қамтиды. Дима "негізгі" ассортименттен келесі модельді таңдады. Ондағы терезе мен есіктің орналасуы оң жақта көрсетілген.



1-сұрақ: ГАРАЖ

Төмендегі суреттерде "негізгі" модельдердің артқы жағында қалай көрінетіні көрсетілген. Осы сызбалардың біреуі ғана Дима таңдаған модельге сәйкес келеді.

Дима қандай модельді таңдады? A, B, C немесе Д.



ГАРАЖ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ

МӘСЕЛЕНІҢ МАҚСАТЫ:

Сипаттама: екі үш өлшемді модельдерді байланыстыру үшін кеңістіктік қабілеттерді пайдаланыңыз.

Математикалық мазмұн саласы: кеңістік және форма

Контекст: Кәсіби

Танымдық белсенділік: түсіндіру

Жауап толығымен қабылданады

1: C

Жауап қабылданбайды

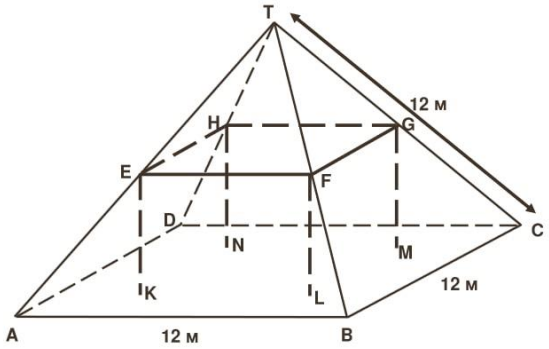
1: басқа жауаптар.

2: жауап жоқ.

6-тапсырма. ФЕРМА

Мұнда сіз пирамида тәрізді төбесі бар ферма үйінің суретін көресіз.

Төменде өлшем бірліктері қосылған берілген үйдің шатырының математикалық моделі көрсетілген.



Модельде ABCD ретінде белгіленген шатыр шаршы болып табылады. Шатырды қолдайтын арқалықтар EFGHKLMN блогының (тікбұрышты призманың) шеттері болып табылады. E нүктесі-AT сәулесінің ортасы, F нүктесі – BT сәулесінің ортасы, G нүктесі – CT сәулесінің ортасы, ал H нүктесі-сәйкесінше DT сәулесінің ортасы. Пирамиданың барлық қабырғаларының ұзындығы 12 метр.

1-сұрақ: ФЕРМА

ABCD шатырының ауданын есептеңіз.

Шатырдың ауданы ABCD = _ _ _ _ _ _ _ _ м2.

ФЕРМА: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ

МӘСЕЛЕНІҢ МАҚСАТЫ:

Математикалық мазмұн саласы: өзгеріс және тәуелділік

Контекст: ғылыми танымдық қызмет: көбейту, анықтамалар, есептеулер

Жауап толығымен қабылданады

1: 144(өлшем бірлігі көрсетілген).

Жауап қабылданбайды

1: басқа жауаптар.

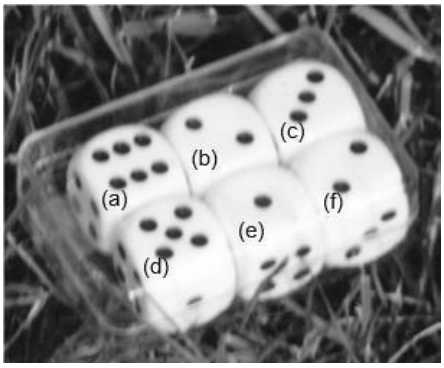
2: жауап жоқ.

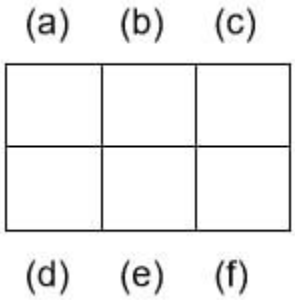
2-сұрақ: ФЕРМА

Блоктың көлденең жиектерінің бірі EF ұзындығын есептеңіз.
Ұзындығы EF = _ _ _ _ _ _ _ _ М.
ФЕРМА: 2-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
МӘСЕЛЕНІҢ МАҚСАТЫ:
Математикалық мазмұн саласы: кеңістік және форма
Контекст: кәсіби танымдық қызмет: мәселені шешу үшін байланыс орнату және ақпаратты біріктіру
Жауап толығымен қабылданады
1: 6 коды(өлшем бірлігі көрсетілген).
Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ.

7-тапсырма. СҮЙЕКТЕР

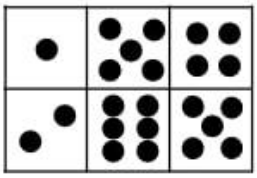
1-сұрақ: сүйектер
Әрқайсысы ережеге бағынады: әр сүйектің екі қарама-қарсы бетіндегі нүктелердің жалпы саны әрқашан жеті (7) болады.
Әр ұяшыққа фотосуретке сәйкес сүйектің төменгі бетіндегі нүктелер санын жазыңыз.





СҮЙЕКТЕР: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
Жауап толығымен қабылданады
1: жоғарғы қатар (1 5 4) төменгі қатар (2 6 5). Сүйек беті ретінде көрсетілген ұқсас жауап та есептеледі.

1	5	4
2	6	5



Жауап қабылданбайды:
1:басқа жауаптар.
2: жауап жоқ.

8-тапсырма. ТЕҢІЗ МЫСЫҒЫНЫҢ ҰЙҚЫСЫ

Теңіз мысығы су астында ұйықтаса да тыныс алуы керек. Мартин теңіз мысығын бір сағат бойы бақылап отырды. Бақылаудың басында теңіз мысығы бетіне шығып, дем алды. Содан кейін ол түбіне сүңгіп, ұйықтап қалды. Түбінен ол 8 минут ішінде баяу бетіне шығып, қайтадан дем алды. Үш минуттан кейін ол қайтадан түбінде болды. Мартин бұл процесс өте тұрақты екеніне назар аударды.

1-сұрақ: теңіз мысығының ұйқысы
Бір сағаттан теңіз мысығы:
A. түбінде болды
B. Көтерілді
C. дем алды
D. Төмендеді
ТЕҢІЗ МЫСЫҒЫНЫҢ ҰЙҚЫСЫ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
Жауап толығымен қабылданады
1: B. Көтерілді.
Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ.

9 – тапсырма. РЕАКЦИЯ УАҚЫТЫ

Қысқа қашықтыққа жүгіруде "реакция уақыты" бастапқы мылтықтың атылуы мен спортшының бастапқы жастықшалардан қозғалуы арасындағы уақыт аралығы деп аталады. "Соңғы уақыт" реакция уақытын да, қозғалыс уақытын да қамтиды.

Келесі кестеде жүз метрлік жарыста сегіз жүгірушінің реакция уақыты мен соңғы уақыты көрсетілген.

Жол	Реакция уақыты (сек)	Соңғы уақыты (сек)
1	0.147	10.09
2	0.136	9.99
3	0.197	9.87
4	0.180	Жарысты аяқтамады
5	0.210	10.17
6	0.216	10.04
7	0.174	10.08
8	0.193	10.13

1-сұрақ: реакция уақыты

Алтын, күміс және қола медаль алған жүгірушілерді анықтаңыз. Төмендегі кестені медаль иегерлерінің трек нөмірлерімен, олардың реакция уақытымен және соңғы уақытымен толтырыңыз.

Медаль		Жол	Реакция уақыты (сек)	Соңғы уақыты (сек)
	Алтын			
	Күміс			
	Қола			

РЕАКЦИЯ УАҚЫТЫ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
Жауап толығымен қабылданады:

Медаль	Жол	Реакция уақыты (сек)	Соңғы уақыты (сек)
Алтын	3	0.197	9.87
Күміс	2	0.136	9.99
Қола	6	0.216	10.04

Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ.

2-сұрақ: реакция уақыты

Осы уақытқа дейін адамдардың ешқайсысы тапаншаның атуына 0.110 секундтан аз уақыт ішінде жауап бере алмады.
Егер жүгірушінің белгіленген реакция уақыты 0.110 секундтан аз болса, жалған бастау орын алды деп есептеледі, өйткені жүгіруші мылтық сигналын естігенге дейін қозғала бастаған болуы керек.
Егер қола жүлдегердің реакция уақыты қысқа болса, оның күміс ұтып алу мүмкіндігі болар ма еді? Жауабыңызды түсіндіріңіз.

РЕАКЦИЯ УАҚЫТЫ: 2-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ

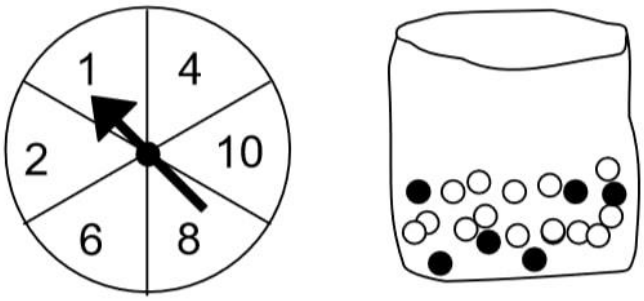
Жауап толығымен қабылданады
1: қолайлы түсіндірмесі бар "Иә".
Иә. Егер оның реакция уақыты 0.05 секундқа жылдам болса, ол екінші орынға көтеріле алар еді.
Иә, егер оның реакция уақыты 0.166 секундтан аз болса немесе сол санға тең болса, ол күмісті ұтып алу мүмкіндігіне ие болар еді.
Иә, мүмкін болатын ең жылдам реакциямен ол 9.93-те жүгіреді, бұл күміс медаль үшін жеткілікті болар еді.

Жауап қабылданбайды
1: басқа жауаптар, соның ішінде" Иә " с жеткілікті дәл түсініктеме жоқ.
2: жауап жоқ.

10-тапсырма. КӨКТЕМГІ ЖӘРМЕҢКЕ

1-сұрақ: көктемгі жәрмеңке

Көктемгі жәрмеңкеде ойнау айналмалы дөңгелекті пайдалануды қамтиды. Егер Доңғалақ жұп санға тоқтаса, ойыншыға сөмкеден бір шарды шығаруға рұқсат етіледі. Айналмалы доңғалақ пен сөмкедегі шарлар төмендегі суреттерде көрсетілген.



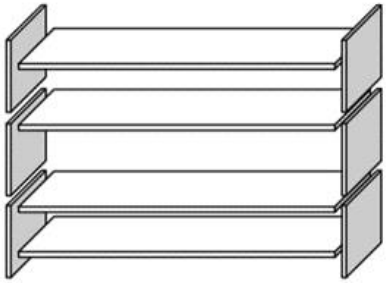
Сыйлықты қара Допты тартқан адам алады. Катя бір рет ойнайды.
Катяның жүлдені жеңіп алу ықтималдығы қандай?
A. Мүмкін Емес.
B. Екіталай.
C. шамамен 50% ықтималдық.
D. өте ықтимал.
E. Дәл.

КӨКТЕМГІ ЖӘРМЕҢКЕ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ

Жауап толығымен қабылданады
1: B. Екіталай.
Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ.

11-тапсырма. КІТАП СӨРЕЛЕРІ

Сөрелердің бір жиынтығын жасау үшін ағаш ұстасына келесі бөлшектер қажет:
4 ұзын ағаш панельдер,
6 қысқа ағаш панельдер,
12 кішкене бекіткіштер және
14 болт.
Ағаш ұстасында 26 ұзын ағаш панельдер, 33 қысқа ағаш панельдер, 200 кішкене бекіткіштер және 510 болттар бар.



1-сұрақ: кітап сөрелері
Ағаш ұстасы қанша сөре жинай алады?
Жауап: .....
КІТАП СӨРЕЛЕРІ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
Жауап толығымен қабылданады
1:5.
Жауап қабылданбайды
1: басқа жауаптар.
2: жауап жоқ

12-тапсырма. ДӘРІ-ДӘРМЕКТІҢ ҚҰРАМЫ
1-сұрақ: дәрі-дәрмектің құрамы
Ауруханадағы әйелге пенициллин инъекциясы беріледі. Оның денесі пенициллинді біртіндеп ыдыратады, сондықтан инъекциядан кейін бір сағаттан кейін пенициллиннің тек 60% - ы белсенді болады.
Бұл процесс қайталанады: әр сағаттың соңында алдыңғы сағаттың соңында қалған пенициллиннің тек 60% - ы ғана жалғасады.
Таңертеңгі сағат 8 - де әйелге 300 миллиграмм пенициллин дозасы берілді делік.
08:00-ден 11:00-ге дейін уақыт аралығында әйелдің қанында жұмыс істейтін пенициллин мөлшерін көрсететін кестені толтырыңыз.

Уақыт	**08:00**	**09:00**	**10:00**	**11:00**
Пенициллин (мг)		**300**		

ДӘРІ-ДӘРМЕКТІҢ ҚҰРАМЫ: 1-СҰРАҚТЫҢ ЖАУАБЫН БАҒАЛАУ
Жауап толығымен қабылданады

1: кестедегі барлық үш позиция дұрыс.

Уақыт	**08:00**	**09:00**	**10:00**	**11:00**
Пенициллин (мг)	**300**	**180**	**108**	**64.8 немесе 65**

Жауап ішінара қабылданады
1: кестедегі бір немесе екі позиция дұрыс.
Жауап қабылданбайды

1: басқа жауаптар.
2: жауап жоқ. [14]

Қорытынды

Тақырыпты зерттей келе айтарымыз:

1. PISA халықаралық салыстырмалы зерттеуі тапсырмалары білім алушылардың теориялық білімдерін емес, олардың алған білімдерін өмірлік проблемаларды шеше алу құзіреттіліктерін сараптайды.
2. Біздің еліміз оқушыларының PISA халықаралық салыстырмалы зерттеуінде өкінішке орай төмен нәтиже көрсетуі осындай сипаттағы тапсырмалардың элементар математика мазмұнында аз қамтылуы деп ойлаймыз.
3. Зерттеу білім беру жүйелерін PISA ұсынғандай халықаралық бағалау стандарттарына бейімдеудің маңыздылығын көрсетеді. PISA есептерін талдау студенттерден білімді ғана емес, сонымен қатар оларды стандартты емес жағдайларда қолдану қабілетін талап ететін нақты, контексттелген мәселелерді шешуге баса назар аударуды көрсетеді. Бұл дәстүрлі есте сақтаудан сыни ойлауға және аналитикалық жұмысқа ауысуды көрсетеді. Бұл тәсіл оқу бағдарламаларынан теориялық білімді қамтуды ғана емес, сонымен қатар оларды өмірлік мәселелерді шешу үшін қолдану дағдыларын дамытуды талап етеді, бұл әсіресе біздің еліміздің студенттері халықаралық салыстыруда көрсеткен төмен нәтижелер аясында өте маңызды.
4. Зерттеу нәтижелері студенттерді PISA-ны ғана емес, сонымен қатар басқа да ұқсас сынақтарды сәтті тапсыруға жақсырақ дайындау үшін оқу материалдары мен оқыту әдістерін қайта қарауға және өзгертуге білім беру бағдарламалары ынталандыруы керек. Халықаралық аренада білім беру стандарттарының өзектілігі мен өзектілігін сақтау елдің әлемдік рейтингтердегі позициясын жақсартып қана қоймайды, сонымен қатар студенттердің оқу және өмірлік құзыреттілігін арттыра отырып, қазіргі әлемнің нақты сын-қатерлеріне дайындалуына ықпал етеді.

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THE IMPORTANCE OF DEVELOPING SKILLS IN USING THE STEM EDUCATION SYSTEM IN CHEMISTRY LESSONS

Abstract. STEM education, encompassing Science, Technology, Engineering, and Mathematics, is increasingly recognized for its vital role in fostering critical thinking, problem-solving, and innovation skills in students. Chemistry, a fundamental STEM subject, offers a unique platform for integrating these disciplines. By developing skills in using the STEM education system in chemistry lessons, students can:enhance their understanding of chemical concepts: STEM-based teaching emphasizes hands-on activities, simulations, and real-world problem-solving, fostering deeper engagement and conceptual comprehension. Develop problem-solving and analytical skills: Chemistry experiments and projects

encourage students to identify, analyze, and solve problems, honing their analytical thinking and critical inquiry abilities.

Keywords: STEM approach, High school chemistry, Integrative Chemisty.

Introduction

STEM is an integrated approach to learning. That is, within this approach, academic scientific and technical concepts are studied in the context of real life. The goal of such an approach is to establish strong connections between school, society, work, and the world at large that contribute to the development of STEM-literacy and competitiveness in the global economy. STEM is an integrated approach to learning in which academic scientific and technical concepts are studied in a real-life context [1].

However, to effectively implement integrated STEM, teachers must have deep knowledge in the science, technological, engineering, and mathematical content they teach [2].

By introducing integrative STEM classes at an early age, students can explore their interests, develop foundational skills, and access potential career paths in STEM-related fields. Integrative STEM classes often include hands-on, inquiry-based learning experiences that engage students and increase intrinsic motivation. By connecting abstract concepts with real-world applications, students see the relevance of what they are learning and are actively engaged in the learning process.

This technology is a new methodology for teaching students based on a comprehensive method of studying and studying a single problem or phenomenon.[3]

Literature review

In modern society, a rapidly changing society requires all the requirements for humanity and their solution remains only the task of knowledgeable learners.

Modernization of high-quality education is based on the use of new technologies are. Education for Natural Sciences an important area is STEM technology training.

Achieving an applied goal, combining several subjects, including the knowledge gained from science lessons. This approach is a bridge that unites the educational process, career and further professional growth in the education system. It allows, through an educational approach, to prepare children for a highly technically developed world.

One of the main trends in world education - the laboratory workshop is considered the main one for teaching physics, chemistry, biology, etc.and other disciplines. The purpose of STEM Laboratories was to deepen the knowledge gained from theoretical concepts, get acquainted with the methods of measuring different quantities, study the work of various instruments, learn technologies for collecting and processing practical data, develop engineering graphics and design skills.[4]

In 2016-2019, within the framework of the state program for the development of the education system and science, this approach was transferred to the updated content of school education. It is planned to include STEM elements in the school curriculum, which is currently planned to be implemented.[5]

As for the main features of STEM, the main elements that use the technology in the classroom include 3D printers, visualization tools and other tools or laboratory equipment. Thus, the ten main advantages of the approach were considered. Thanks to the new technology: teenagers develop a motor effect, become more interested in theory, understand its importance. We can independently plan project

research work. Talented students are formed who are able to create new devices and are confident in their abilities. The main thing is that competitiveness develops.[6]

Teachers are looking for the best, most effective ways for students when using any technology, methods and techniques. The student receives first theoretical knowledge for the development of knowledge in biology, physics, chemistry, as well as in the disciplines of the Natural Science direction, improving mathematical, scientific and academic literacy. Aspects of its use at a high level in the context of real life are not considered. It is necessary to provide high school students with the opportunity to qualitatively apply the theoretical knowledge gained by studying these natural sciences. In 2017, STEM for the development of Technology, about 6 million for the creation of a laboratory. "I don't know," he said.[7]

STEM is a combined teaching method that addresses academic scientific and technical concepts in real life. The purpose of this method is to create a stable connection between school, community, work and the world, which contributes to the development of STEM literacy and competitiveness in the global economy.

The use of the STEM method in the learning process contributes to the development of the following skills in students:

- solving any problem;
- be creative with the action;
- critical analysis;
- independent thinking;
- work together in a team;
- give initiative to new ideas;
- digital literacy.[8]

The expected results in the development of skills in using the STEM education system are expected: a supportive and motivating atmosphere, continuous scientific, methodological and psychological support for adolescents. The educational process between the student and the teacher is built on cooperation, that is, on the basis of the principle of Subject-subject interaction. It is expected that classes will be held in schools using only new technologies, students will develop critical thinking and problem-solving skills. Improving professional competencies or the literacy of teachers and students in STEM technology.

In modern society, the virtual process in the conditions of Secondary Education is thus aimed at using the pedagogical potential of traditional education, bringing it to the level of new, virtual computer technologies. In chemistry classes, this technology is what we call the most necessary approach for students to learn, because this methodology or context from a foreign country not only teaches chemistry, but also integrates topics within chemistry. Integrated learning means that it increases the competence of students to understand this topic. This means a good opportunity for students of the Republic of Kazakhstan. In general, the future of our state is connected with educated youth.

Research question

What is the importance of developing skills in using the STEM education system in Chemistry Lessons?

Methodology

In accordance with the topic of the article, the theoretical foundations of this technology should be determined. The study of scientific works carried out in the direction of research, the developed teaching aids allows us to identify mainly theoretical bases, concepts of research using the method of analysis.

Sampling

To achieve the goal, we reviewed 10 scientific works, including scientific journals, articles, methodological books.

Article name (author, year of publication)	Description
Aydin-Gunbatar, S., Ekiz-Kiran, B., & Oztay, E. S. (2020).	STEM education integrated with a problem-based learning in the study of stoichiometry.
Mutakinati, L., Anwari, I., & Kumano, Y. (2018).	This research is to investigate the students` critical thinking skill by using STEM education through Project Based Learning.
Sutaphan, S., & Yuenyong, C. (2019, October).	To develop theoretical framework for STEM teaching strategies in school setting.
Sari, N. A., Mulyani, S., Hastuti, B., & Indriyanti, N. Y. (2021, March)	To analyse the level of STEM literacy and problem solving of students in chemistry materials.
Hacıoğlu, Y., & Gülhan, F. (2021)	To research the effects of engineering design-based STEM education on the middle school students' critical thinking skills and STEM perceptions.
Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021).	STEM-focused professional development and implementing integrated STEM lessons into their classrooms.
Baharin, N., Kamarudin, N., & Manaf, U. K. A. (2018).	STEM approach in the learning and teaching process that is able to enhance thinking skills among students.
Sari, N. A., Mulyani, S., Hastuti, B., & Indriyanti, N. Y. (2021, March).	To analyse the level of STEM literacy and problem solving of students in chemistry materials.
Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012).	A problem-based approach in the teaching of STEM.

Aminah, S. (2022).	Critical thinking skills has to be sharpened particularly during the COVID-19 pandemic. This circumstance leads to the lack of student's passion to apply their thinking skills in doing something necessary.

Data collection

During the research, I searched for articles on the topic of building skills in using the integrated STEM education system in chemistry education in Google Scholar. I studied various academic databases to find relevant literature and critically evaluated, familiarized myself with the suitability of each article for solving research goals. This process helped to ensure that only relevant and high-quality articles were included in the analysis, which contributed to my full understanding of the subject of chemistry on the formation of skills for use not only in the educational system, but also in the education system as a whole.

Data analysis

The frequency and percentage of students` competencies were calculated and analyzed.

№	Skills	Frequency	Percentage
1	Critical thinking skills	6	60%
2	Problem-solving skills	1	10%
3	Scientific thinking skills	1	10%
4	Creative thinking skills	1	10%
5	Explorative skills	1	10%
6	The application of knowledge in life	1	10%

Result

If we analyze the tables presented above,we studied 10 articles and analyzed 6 skills.As shown in the table, we can see that the most critical thinking skills are found in 6 articles , i.e. 60%, i.e. 10 articles. It can be seen that the rest of the articles came across only one in the article I received.

In conclusion**,** developing skills in using the STEM education system in chemistry lessons is crucial for fostering comprehensive learning and preparing students for success in STEM fields and beyond.

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DETERMINING INTERACTIVE ONLINE RESOURCES IN TEACHING CHEMISTRY LABORATORY

Abstract. In this review paper we will determine the interactive online resources. Here, we analyzed educational research studies related to the specifically chemistry laboratory courses. This paper provides us the types of virtual lab, learning platforms, simulators, educational web sites that used to teach chemistry laboratory in nontraditional format. And we can see that the impact of COVID 19 to the educational research on online learning boosting.

Keywords: interactive online resources, teaching chemistry laboratory, chemical Virtual laboratory, learning platforms.

Introduction

In the field of education, the use of online interactive resources has revolutionized to a new level of teaching and learning methods. These resources provide students with easy access to materials and interactive tools that enhance their understanding of complex concepts in science. The explosion of technology has also made possible teaching outside of the traditional classroom laboratory. It helped to solve the problems that accrued when the chemistry laboratory courses needed to be conducted online. Laboratory instruction unifies conceptual and procedural knowledge, and constitutes an important part of chemistry education practice (Reid and Shah, 2007). Also, it was beneficial on the case of shortage of tools and reagents in the laboratory, leading to limited hands-on experience. This creates a challenge in teaching chemistry laboratory. Therefore, this heeded find alternative ways to optimize learning in the laboratory. The Virtual laboratory environments have emerged as a potential solution of the faced problem. By offering students a simulated laboratory experience that can be accessed online. Virtual laboratories or laboratory simulations have been used for two main purposes in chemistry education. Firstly, they have been used to provide students with visual representations of chemistry concepts, and secondly, they have been used to prepare students for their laboratory sessions. (Dalgarno, Bishop, Adlong, Bedgood Jr., 2009, 854). Also, learning platforms and multimedia resources allow students to visualize and interact with the feelings that will be experienced during experiments, improving their understanding of the traditional laboratory environment.

Literature review

The study carried out by a literature review and analyzing research from previous studies. To get the only relevant studies defined the inclusion and exclusion criteria to limit the searching process. The criteria for eligibility include a) the paper must emphasize on interactive online chemistry laboratory

tools focused on educational research; b) language must be in English; and c) the studies should be published from 2014 onwards. To search for research information, were used electronic databases such as Scopus, Web of Science and Google Scholar. The keywords used in the search queries were "online interactive resources", "interactive online laboratory", "teaching chemistry laboratory" and "Virtual Laboratory".

Through the keywords, we found and collected more than 30 articles. The range of years selected was from 2014 to 2024. Here is the one thing to highlight that biggest part of papers were studied after or during the COVID 19 lockdown. When the instructors forced to switch from offline traditional to online classes. Firstly, we read the summary and evaluated the content of each article to ensure its suitability for our study. Then, we filtered the documents according to our scope. Eight documents are listed in the tool as shown in Table 1 below.

Reference	Year	Description	Interactive online Tool
[1]	2021	The method that used to teach chemistry laboratories during lockdown.	-Live demonstration video watching.
[9]	2020	Teaching laboratory during COVID 19 lockdown.	- online lab simulator, - remote devices
[2]	2020	Online multimedia resources were implemented in laboratory courses.	-Video -simulation
[10]	2022	Free, interactive, and widely accessible chemical education resources.	-BACON (Biology and Chemistry Online Notes -Backside Attack, a smartphone game -QR Chem, a site that allows students, instructors, and researchers to create QR codes that link to interactive 3D structures. -R/S Chemistry
[16]	2018	Teaching chemistry with ICT tools in Czech Republic and Kazakhstan.	-The PhET Interactive Simulation -Virtual kids lab
	2022	The compilations of chemistry laboratory course during COVID 19	-Live demonstration with daily used things.

[13]	2024	Online laboratories that helped teaching chemistry laboratory course during COVID 19.	-ChemCollective virtual laboratory -you tube videos
[3]	2021	General chemistry lab programs by using interactive online resources	Remote lab

Table 1

Data analyze

Reference	Online Resources	Frequency	Percentage
[2], [5],[6],[7], [10],[11],[13], [15],[19]	Virtual lab	9	45%
[4],[11],[15]	Simulator	3	15%
[1],[2],[8]	Learning website	3	15%
[2],[5],[9], [17],[18]	Video	5	25%
[3],[20]	Remote laboratory	2	10%

According to the result virtual lab and video record of lab demonstration method were mostly used in online chemistry laboratory courses. The difference between Virtual lab and simulator is virtual lab simulate laboratory experiences in a digital environment. And simulators model the behavior of real-world systems or processes to provide training or testing. A learning website is a platform that hosts educational content and resources for acquiring knowledge and skills across various subjects. Remote laboratories enable to access equipment or computers via the internet to perform experiments and laboratory tasks without being in the physical lab space. But this equipment comparatively is expensive that not all institutions can afford.

Conclusion

In conclusion, this paper determined 5 online interactive recourses that used in teaching chemistry laboratories. There are virtual labs, simulators, learning platforms, multimedia (video) and remote labs. We tried to find the alternative way to conduct the laboratories to get the results as traditional method. The main criteria were flexible, free, and affordable tools.

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SEARCHING INTEGRATED STEM FRAMEWORKS IN CHEMISTRY

Abstract. This study explores the incorporation of STEM (Science, Technology, Engineering, and Mathematics) frameworks in Chemistry education through thorough analysis and evaluation. Utilizing established STEM frameworks as a basis, the research employs comparative analysis to assess their effectiveness within Chemistry. Through literature review and research analysis, the prevalence of integrated approaches, termed "Integrated Chemistry," is evident. Methods include identifying common themes, evaluating alignment with Chemistry curriculum standards, and exploring interdisciplinary

connections. The findings demonstrate the advantages of integrating STEM frameworks in Chemistry education, including enhanced interdisciplinary learning, improved critical thinking skills, and increased student engagement. This analysis emphasizes the importance of adopting integrated STEM approaches to enrich Chemistry education and prepare students for future endeavors. By examining the benefits and challenges, this abstract underscores the need for further research to enhance pedagogical practices and curriculum development in Chemistry education.

Keywords: STEM approach, High school chemistry, Integrative Chemistry

Introduction

In recent times, there has been a growing emphasis on the significance of offering students top-notch education in STEM subjects. Skilled professionals in these fields are essential for sustaining economic competitiveness globally and addressing contemporary needs like sustainable energy consumption, robust healthcare systems, and technology development with social and environmental considerations. [1] *(Boe et al., 2011)*

The primary focus of education for every student should be to attain proficiency in STEM literacy, encompassing comprehension of fundamental principles in science, technology, engineering, and mathematics, along with acquaintance with essential concepts from each discipline. [2] *(Bybee, 2010; National Academy of Engineering and National Research Council, 2014).*

One effective strategy in this context involves implementing an integrated STEM A successful approach in this scenario includes introducing a unified STEM curriculum, providing opportunities for students to participate in enhanced, coherent, and captivating learning opportunities. [3]*(Furner and Kumar, 2007, p.186).*

Literature review

Integrated STEM Frameworks in Chemistry Education.

In the field of education, there has been a marked shift towards the integration of science, technology, engineering and mathematics (STEM) within various disciplines in order to provide students with a comprehensive learning experience. In the field of chemistry education, the study of integrated STEM systems has received significant attention, reflecting a broader commitment to developing interdisciplinary thinking and preparing students for the complex challenges of modern science. For example, tasks such as interdisciplinary pedagogy, influence on education, authentic problem-finding and problem-solving, solving social problems.

Integrated STEM systems facilitate the smooth integration of concepts from various disciplines, encouraging teachers to move beyond traditional subject boundaries. In chemistry education, this approach involves combining the principles of chemistry, physics, mathematics, and engineering to provide students with a holistic understanding of scientific phenomena. Using the interdisciplinary nature of STEM, teachers strive to develop important skills in students such as critical thinking, problem solving, and collaboration.

Scientific research on integrated STEM approaches in chemistry education has identified their potential to improve learning outcomes and student engagement. Scientific research has shown that students enrolled in integrated STEM curricula demonstrate a deeper conceptual understanding and increased motivation compared to their counterparts in traditional educational institutions. In addition, it

has been proven that the integrated STEM experience contributes to the development of a sense of relevance and applicability in real conditions, enriching the educational experience of students.

Central to integrated STEM systems is the promotion of authentic search and practical problem solving. Instead of passively receiving information, students are encouraged to actively explore scientific phenomena through experiments and project-based learning activities. By participating in authentic research, students develop a deeper understanding of the scientific process and acquire necessary skills such as hypothesis testing, data analysis, and experiment planning.

One of the key strengths of integrated STEM systems in chemistry education is their ability to solve complex social problems. By looking at chemistry in a broader social, environmental, and technological context, teachers can help students address real-world issues such as environmental sustainability, renewable energy, and healthcare. Through an interdisciplinary approach, students gain the knowledge and skills necessary to make a meaningful contribution to society and become informed citizens of the world.

Challenges and considerations: Despite the potential benefits, the introduction of integrated STEM systems into chemistry education is fraught with certain difficulties. Teachers should address issues such as teacher development, curriculum alignment, access to resources, and fair assessment strategies. In addition, efforts to promote diversity, equality and inclusivity through integrated STEM programs are necessary to ensure that all students have equal access to high-quality educational experiences. The integration of STEM disciplines in chemistry education represents a promising approach to enriching student learning experiences and preparing them for future scientific endeavors. By embracing integrated STEM frameworks, educators can foster interdisciplinary thinking, promote authentic inquiry, and empower students to address complex societal challenges. However, addressing the associated challenges and considerations is crucial to realizing the full potential of integrated STEM approaches and ensuring equitable access to quality education for all students.

The purpose of this study is to analyze existing integrated STEM approaches in chemistry education in order to identify the basic frameworks and principles that contribute to effective learning. **“**What kinds of frameworks are met in literature?” is identified as a research question.

Methodology

An extensive review of academic articles related to integrated approaches in chemistry education was conducted, with particular attention to aspects of integrated STEM structures. Working with keywords such as "Integrated Chemistry" and "Searching integrated STEM frameworks in Chemistry education" allowed us to identify relevant studies and articles for inclusion in the analysis. The study of the articles and their comparison made it possible to identify the key components and principles of integrated STEM approaches used in the context of chemistry education.

Sampling

Article name (author, year of publication)	Description

Smith, J., & Johnson, A. (2020).	The article focuses on integrating STEM into chemistry education.
Garcia, M., & Martinez, R. (2019).	This literature delves into a case study in chemistry education, providing deeper insights into integrated STEM frameworks, aligning directly with the research objective.
Lee, C., & Kim, D. (2021).	This review highlights integrating engineering design into chemistry education, a vital part of STEM integration, broadening our understanding of STEM in chemistry.
Y., & Chen, L. (2018).	This literature explores math's role in integrated STEM in chemistry education, offering insights into interdisciplinary approaches.
Diana Laboy-Rush (2016)	This article explores how project-based learning in STEM motivates students with real-world challenges, emphasizing the role of teacher support.
Tamara J. Moore, Gillian H. Roehrig, and Tandra Tyler-Wood (2014)	This article explores STEM integration in middle schools, suggesting design-based curriculum planning to enhance it.
Frank Weinhold, Bradley W. Duerstock (2008)	Explores the relationship between chemistry and engineering in STEM.
Jody Bintz, Christine K. Nyberg, and Emily Thomas (2015)	The article explores integrating technology into education to enhance STEM learning in secondary schools.
Marcy H. Towns (2009)	The article aims to explore the current status of chemistry within the STEM movement and predict its future trajectory
Sarah J. Carrier, Susan B. Capobianco, and Gillian H. Roehrig (2007)	The article investigates how STEM integration impacts student learning and explores effective pedagogical strategies for teachers in middle school science

Data collection

During the research, I searched for articles in Google Scholar, related to integrated STEM frameworks in chemistry education, particularly focusing on the keyword "Integrated Chemistry". I explored various academic databases to find relevant literature and critically evaluated each article's suitability for addressing the research objectives. This process helped ensure that only pertinent and high-quality articles were included in the analysis, contributing to a comprehensive understanding of integrated STEM frameworks in chemistry education.

Data analysis

In analyzing the topic "Searching integrated STEM frameworks in Chemistry," I found that the keywords "Integrated chemistry" are widely used in literature and research. These frameworks aim to integrate chemical concepts with other STEM fields, improving understanding of interconnections among scientific disciplines. Further research could enhance our understanding of the advantages and limitations of such approaches in chemistry education.

Result

Article (Author, Year)	Frameworks and principles	Frequency	Percentage
1)"Incorporating Engineering Design in Chemistry Curriculum: A Literature Review" Lee, C., & Kim, D. (2021) 2) "Chemistry and engineering: a STEM synergy", Frank Weinhold and Bradley W. Duerstock (2008)	Engineering design	2	20%
1)Integrated STEM Education through Project-Based Learning, Diana Laboy-Rush (2016) 2) "STEM Integration in Middle School: A Design-Based Approach to Supports and Constraints" (2014)	Project-based	2	20%
"STEM integration in middle school science: student learning and teacher pedagogical strategies", Sarah J. Carrier, Susan B. Capobianco, and Gillian H. Roehrig (2007)	3D printing	1	10%

"The Role of Chemistry in the STEM Movement: Where We Are and Where We Are Going" , Marcy H. Towns (2009)	PBL (Problem-based Learning)	1	10%
1) "Integrating STEM Concepts into Chemistry Education: A Comprehensive Review." Smith, J., & Johnson, A. (2020) 2)"Exploring Integrated STEM Frameworks: A Case Study in Chemistry Education." Garcia, M., & Martinez, R. (2019). 3) "The Role of Chemistry in the STEM Movement: Where We Are and Where We Are Going", Marcy H. Towns (2009) 4) "Chemistry and engineering: a STEM synergy", Frank Weinhold and Bradley W. Duerstock (2008)	Chemistry connection	4	40%

During my research, I explored integrated STEM systems in chemical education, emphasizing interdisciplinary learning experiences and pedagogical improvement in a STEAM environment. My conclusions identify five key structures and principles: engineering design, project based, 3D printing, PBL (problem-based learning), and chemical design. These findings, derived from literature review and personal observations, offer insights into existing integrated STEM approaches in chemistry education and highlight principles for effective learning.

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8. "Chemistry and engineering: a STEM synergy", Frank Weinhold and Bradley W. Duerstock (2008)
9. Integrated STEM Education through Project-Based Learning, Diana Laboy-Rush (2016)
10. "STEM Integration in Middle School: A Design-Based Approach to Supports and Constraints" (2014)
11. "STEM integration in middle school science: student learning and teacher pedagogical strategies", Sarah J. Carrier, Susan B. Capobianco, and Gillian H. Roehrig (2007)
12. "The Role of Chemistry in the STEM Movement: Where We Are and Where We Are Going", Marcy H. Towns (2009)

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5-9 СЫНЫП ОҚУШЫЛАРЫ ҮШІН STEM ТЕХНОЛОГИЯСЫН МАТЕМАТИКАҒА КІРІКТІРУ

Аннотация. 21 ғасырда оқушыларды күрделі мәселелерді шешуге дайындау үшін STEM (ғылым, технология, инженерия және математика) білім беру жүйесіне кіріктіру маңыздырақ болып отыр. Математика STEM негізі бола отырып, осы пәндерді біріктіруде маңызды рөл атқарады. Бұл мақалада 5-9 сынып оқушылары үшін STEM-ді математикаға енгізудің артықшылықтары мен стратегиялары қарастырылады. Көпір дизайны, ауа райы деректерін зерттеу, робототехника және қаржылық модельдеу сияқты математикалық мазмұнға STEM тұжырымдамаларын біріктіретін сабақтар мысалдары берілген. Мақалада STEM интеграциясы математикалық ұғымдарды тереңірек түсінуге ықпал ететіні, проблемаларды шешу және сыни тұрғыдан ойлау дағдыларын дамытатыны, математикаға қызығушылықты арттыратыны және оқушыларды STEM-ге қатысты салалардағы болашақ мамандық таңдауда үлкен мүмкіндіктеріне ие болатынын атап өтілген.

Кіріспе

21 ғасырда студенттерді күрделі мәселелерді шешуге дайындау үшін STEM (ғылым, технология, инженерия және математика) білім беру жүйесіне кіріктіру маңыздырақ болып отыр. STEM білім беру әртүрлі салалар мен салаларда табысқа жету үшін қажетті сыни ойлауды, мәселелерді шешуді және топта жұмыс істеу дағдыларын дамытады. Математика STEM негізі бола отырып, осы пәндерді біріктіруде маңызды рөл атқарады.

STEM-ті математикаға енгізудің пайдасы

STEM-ді математикаға интеграциялау оқушыларға бірқатар артықшылықтар береді, соның ішінде:

• Математикалық ұғымдарды түсінуді арттыру
• Мәселені шешу және сыни тұрғыдан ойлау дағдыларын дамыту
• Математикаға деген қызығушылықтарын арттыру
• STEM салаларындағы болашақ мансапқа дайындалу

• Математиканы нақты әлемде практикалық қолдануды көрсету

Математикаға STEM интеграциясының мысалдары

STEM-ді математикалық білімге енгізудің көптеген жолдары бар. Міне, кейбір мысалдар:

5-6 сыныптар

Көпір жобасы: Оқушылар белгілі бір салмақты көтере алатын қағаз көпірді жобалау және салу үшін өлшем, аудан және көлем сияқты геометриялық ұғымдарды қолданады.

Ауа райы деректерін зерттеу: Оқушылар үлгілерді анықтау және болашақ ауа-райын болжау үшін орташа, медиана және режим сияқты статистикалық әдістерді пайдаланып температура, жауын-шашын және жел деректерін талдайды.

7-8 сыныптар

Робототехника: Оқушылар жылдамдық, қашықтық және уақыт сияқты математикалық ұғымдарды пайдалана отырып, нақты тапсырмаларды орындау үшін роботтарды бағдарламалайды және құрастырады.

Күн жүйесін жобалау: Оқушылар күн жүйесіндегі планеталардың өлшемдері мен арақашықтығын есептеу үшін алгебралық теңдеулерді пайдаланады.

9 сынып

Қаржылық модельдеу: Студенттер экспоненциалды өсу және күрделі пайыз ұғымдарын пайдалана отырып, инвестициялық өсуді болжау үшін математикалық модельдер жасайды.

Үй дизайны: Оқушылар аумақ, бөлмелер саны және энергия тиімділігі сияқты нақты талаптарға сәйкес келетін үй жоспарын жасау үшін геометрия мен тригонометрияны пайдаланады.

Табысты STEM интеграциясының стратегиялары

STEM-ді математикаға сәтті енгізу үшін мұғалімдер келесі стратегияларды қарастыруы керек:

Оқу жоспарын сәйкестендіру: STEM сабақтары математикалық оқу бағдарламасына сәйкес келуі және мұқият жоспарланған болуы керек.

Тәжірибелік оқыту: Оқушыларға тәжірибелік оқу және эксперимент жүргізу мүмкіндіктерін беру STEM тұжырымдамаларын түсіну үшін өте маңызды.

Ынтымақтастық: математика, жаратылыстану және технология мұғалімдері арасындағы ынтымақтастықты ынталандыру оқу тәжірибесін байыта алады.

Бағалау: Оқушылардың жұмысын бағалау математикалық дағдыларды да, есептер шешу және сыни ойлау сияқты STEM дағдыларын да көрсетуі керек.

STEM-ді математикаға кіріктіру оны қызықтырақ, мағыналы және шынайы өмірде қолдануға болатындай етіп, оқушылардың оқуын жақсартады.

Нақты әлем мәселелерін қолданыңыз. Оқушыларға математиканың күнделікті өмірде қалай қолданылатынын көрсетіңіз, мысалы, бюджетті құру, демалысты жоспарлау немесе ғимаратты жобалау.

Технологияны біріктіру. Математиканы оқуды қызықты әрі интерактивті ету үшін интерактивті тақталар, модельдеу және қолданбалар сияқты құралдарды пайдаланыңыз.

Топтық жұмысты ынталандыру. Оқушыларға STEM жобалары мен тапсырмалары бойынша бірлесіп жұмыс істеуге мүмкіндік беріңіз. Бұл олардың қарым-қатынас, проблемаларды шешу және сыни ойлау дағдыларын дамытуға көмектеседі.

Математиканы басқа пәндермен байланыстыру. Оқушыларға математиканың ғылыммен, технологиямен және техникамен байланысын көрсетіңіз. Мысалы, сіз математиканы ғылыми экспериментті модельдеу немесе инженерлік шешімді жобалау үшін пайдалана аласыз.

Математикалық жобаларды құру

Математикалық жобалар студенттерге белгілі бір тақырыпты тереңірек меңгеруге және алған білімдерін нақты әлемдегі жағдайға қолдануға мүмкіндік беретін тамаша әдіс болып табылады. Міне, математикалық жобаларға арналған кейбір идеялар:

Зерттеу жобасы. Оқушылардан белгілі бір математикалық тақырыпты зерттеуді және олардың нәтижелері бойынша есеп дайындауды сұраңыз.

Модельдеу жобасы. Оқушылардан объектінің қозғалысы немесе популяцияның өсуі сияқты нақты өмірлік жағдайдың математикалық моделін құруды сұраңыз.

Дизайн жобасы. Оқушылардан пішінді оңтайландыру немесе маршрутты жоспарлау сияқты мәселенің математикалық шешімін әзірлеуді сұраңыз.

Қолданбалы жоба. Оқушыларға қаржыны қадағалау немесе оқиғаларды жоспарлау сияқты нақты мәселелерді шешу үшін математиканы пайдаланатын қолданба жасауды сұраңыз.

Математикалық жобалар жеке немесе топтық болуы мүмкін. Олар қысқа мерзімді немесе ұзақ мерзімді болуы мүмкін. Ең бастысы, олар көңілді, мағыналы, тәрбиелік мәні зор болуы керек.

Қорытынды

5-9 сынып оқушылары үшін STEM (жаратылыстану, технология, инженерия және математика) пәнін математикаға кіріктіру оларды күрделі есептерді шешуге және болашақ мансабында табысқа жетуге дайындау үшін өте маңызды. STEM тұжырымдамаларын математикалық мазмұнға кіріктіру математикалық түсініктерді түсінуді арттырады, есептерді шешу және сыни тұрғыдан ойлау дағдыларын дамытады, математикаға қызығушылықты арттырады және 21 ғасыр талаптарына жауап береді.

Осы мақалада берілген үлгілік сабақтар мен STEM интеграциясы стратегияларын мұғалімдер студенттерді күрделі мәселелерді шешуге және мектепте және мансапта табысқа жетуге дайындайтын динамикалық және тартымды оқу ортасын құру үшін бейімдей алады.

Әлем технологиялық тұрғыдан дамыған сайын және өзара байланысты болғандықтан, STEM-ті білім беруге интеграциялау маңыздырақ болып отыр. Оқушыларға тәжірибелік, проблемалық оқыту мүмкіндіктерін бере отырып, мұғалімдер оларды болашақ қиындықтар мен мүмкіндіктерге дайындай алады.

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EXECUTING THE INTEGRATIVE STEM LESSON UNIT PLAN FOR SCHOOL

Abstract. The results of scientific research on the topic" implementation of an integral plan of STEM Lessons for school " were analyzed. The systematically developed STEM lessons section plan helps the student awaken student creativity in stem practice programs and activities, developing skills rather than science and math-oriented concepts in the 21st century, including teaching media and technology literacy, productivity, social skills, communication, flexibility, and initiative.

Keywords: STEM, chemistry, education

Introduction

In secondary education, chemistry offers a window into the fundamental nature of the world and its materials. Mastery of this subject demands a solid grasp of its basics, typically taught in the 9th-gradecurriculum.

As we enter the 21st century, traditional teaching methods falter in the face of evolving generations and technological advancements. An urgent need arises for innovative approaches that leverage modern technologies to enhance learning outcomes. Integrated school programs, advocated since 2010, encounter obstacles, primarily due to vague understanding of integrated learning, hindering the implementation of STEM.

Effective integration of all four STEM fields proves most beneficial, fostering comprehensive understanding and interdisciplinary connections. Real-life applications of scientific knowledge aid in comprehension, while integrative teaching motivates both teachers and students. Crucially, engaging students in engineering design challenges underscores the importance of leveraging engineering technologies for educational advancement. Chemistry in secondary education thus becomes a gateway to broader interdisciplinary learning, vital for preparing students for the challenges of the future.

Literature review

The study by Sari, N. A., Mulyani, S., Hastuti, B., & Indriyanti, N. Y. (2021, March) aims to assess the level of STEM literacy and problem-solving skills among grade twelve students in chemistry materials, within the context of 21st-century learning expectations. Conducted in Sragen Regency, Indonesia, the research involved seventy participants and employed a qualitative methodology. Questionnaires comprising open-ended questions were distributed, covering six cases with ten items each, addressingscience literacy, mathematical literacy, technology-engineering literacy, and problem-solving. Results indicate a prevalent deficiency in STEM literacy and problem-solving abilities among the students. Notably, the majority lacked proficiency in these areas, indicating a misalignment with the expectations of21st-century learning paradigms. This research underscores the pressing need for targeted interventions to enhance STEM literacy and problem-solving skills within the Indonesian education

system. The findings highlight a critical gap between educational goals and student proficiency, emphasizing the imperative for reforms aimed at fostering these essential competencies among students.

Implementing the STEM approach in chemistry education addresses societal needs and enhances students' skills. While previous STEM research primarily focused on student skill improvement, your study aimed to gauge chemistry teachers' perceptions of this approach. Using a purposive-design survey method, 37 chemistry teachers in Central Java, Indonesia, participated, employing random sampling. Results indicated positive teacher perceptions towards integrating STEM into chemistry learning. However, challenges like teacher unfamiliarity and time constraints hindered implementation. Nevertheless, teachers believe STEM application can enhance students' 21st-century skills. This research underscores the importance of considering educators' perspectives in educational innovation, emphasizing the potential benefits and obstacles of integrating STEM in chemistry classrooms.

Methodology

A comprehensive review more 20 academic articles fulfilling the plan of the Integrative STEM lesson plan for the school for the study of chemistry was carried out, 10 of which were analyzed, special attention was paid to aspects of the structure of the Integrative STEM lesson plan for the school in Chemistry Lessons. Working with keywords such as "STEM", “chemistry", "education" made it possible to identify relevant research and articles for inclusion in the analysis. The study of articles and their comparison made it possible to identify the main components and principles of the methods of implementing the executing the Integrative STEM Lesson Unit Plan for school used in the context of teaching chemistry.

Sampling

In order to accomplish the goal, we examined 10 scientific publications, including methodological books, essays, and scientific journals.

Article name (author, year of publication)	Description
Çalış, S. (2020).	Teachers tackled challenges in creating STEM lesson plans involving real-life problems, integrating scientific knowledge, and ensuring material disclosure.
Duangsri, T., Chomchid, P., & Phusopha, J. (2017).	This study aimed to develop a creative STEM lesson plan for efficient performance and processing outcomes.

Sutoyo, S., Azizah, U., & Allamin, S. (2019).	The study investigates the efficacy of integrating a guided inquiry model with STEM to enhance student critical thinking skills using the 4-D model.
Koes-H, S et al. – 2021.	This work can influence the design of learning activities in STEM education.
Aydin-Gunbatar, S., Ekiz-Kiran, B., & Oztay, E. S. (2020).	It showed that a new model, Laser, has been proposed that requires time and support for effective integrated STEM education.
Chien, H. (2019)	To provide learners autonomy over planning, information, learning strategies, and student evaluation through the presentation of the design process for a competence framework for STEM education.
Karpudewan, M., & Daman Huri, N. H. (2022)	STEM-lab offers four interdisciplinary activities in electrochemistry
Eid, A. -2014	To create a chemistry unit that exemplifies the integration of technology, pedagogy, and content to promote STEM-related study and vocations.
Siregar, L., & Silaban, S. (2023)	To develop a STEM-based chemistry module that will improve the activities and learning results for students.
Syukri, M., Yanti, D. A., Mahzum, E., & Hamid, A. (2021)	To enhance students' science process abilities in physics learning by creating a Learning Program Plan (LPP) using a PjBL model based on the STEM method.

Data collection

During my research work, I searched for articles on the topic "implementation of an integrated STEM lesson plan for school" in Google Scholar, especially paying attention to the keywords "STEM", "chemistry", "education". I studied various academic databases to find relevant literature and critically evaluated the ways in which each article addressed the research objectives. This process helped to ensure

that relevant and high-quality articles were included in the analysis on the topic, which contributed to a comprehensive understanding of the application of the implementation of the integrated STEM lesson plan for school.

Data analysis

After carefully examining each article, I discovered that ten of them fully addressed the study's goals and provided insightful details about the usefulness and real-world applications of project-based learning when implementing the unit plan for an integrated STEM lesson in the classroom.

Result

Based on the results of a comprehensive analysis of the data, it includes various approaches to teaching the implementation of the Integrative STEM lesson plan for school. In addition, many studies have concluded that using the STEM method provides opportunities for students and helps improve students ' abilities. In the study of articles, I focused on 4 part. First, keywords should be considered in the research work and correspond to the purpose of the study. I noticed that the STEM method is used not only in secondary and higher educational institutions, but also in universities. The practical parts of these works are devoted to the implementation of the lesson plan of high school students about 80%. In each item we reviewed, the use of chemistry STEM lesson plan 60% and 40% provided models.

Article №	Author, main idea	Categories			Respect for the work's objective yes/no
		Key issue	Unit plan/ Model	School/ university	
1	Çalış, S. (2020).	+	Unit plan	school	yes
2	Duangsri, T., Chomchid, P., & Phusopha, J. (2017).	+	model	school	yes
3	Sutoyo, S., Azizah, U., & Allamin, S. (2019).	+	model	school	yes
4	Koes-H, S et al. – 2021.	+	Unit plan	school	yes
5	Aydin-Gunbatar, S., Ekiz-Kiran, B., & Oztay, E. S. (2020).	+	model	university	yes
6	Chien, H. (2019)	+	Unit plan	university	yes
7	Karpudewan, M., & Daman Huri, N. H. (2022)	+	Unit plan	school	yes
8	Eid, A. -2014	+	Unit plan	school	yes
9	Siregar, L., & Silaban, S. (2023)	+	Unit plan	school	yes
10	Syukri, M., Yanti, D. A., Mahzum, E., & Hamid, A. (2021)	+	model	school	yes
Total		100%	60%	80%	100%

Conclusion

In conclusion, I analyzed the results of the "**Executing the Integrative STEM Lesson Unit Plan for school**". I made sure that a systematically compiled lesson plan helps students build a solid foundation for scientific principles, critical thinking skills, and problem-solving abilities.

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REVIEW ON CONTENT KNOWLEDGE OF CHEMISTRY TEACHERS

Abstract. Chemistry plays a vital role in developing scientific literacy and critical thinking skills in students. Effective teaching in this field depends heavily on chemistry teachers' deep content knowledge and pedagogical skills. Research highlights the importance of Content Knowledge (CK), which links teachers' understanding of chemical concepts with their teaching methods. Teachers with strong content expertise can employ effective strategies, resulting in better student engagement and achievement. This study examines the relationship between teachers' content knowledge, instructional practices, and student learning outcomes, aiming to inform targeted professional development and enhance chemistry education in secondary school settings.

Keywords: Content knowledge, chemistry teachers, teacher's expertise

Introduction

In modern education, chemistry plays a key role in the formation of scientific literacy and the development of students' critical thinking. However, the success of this process largely depends on the qualifications of chemistry teachers, who are not only knowledge carriers, but also active shapers of the educational environment. The basis for effective teaching of chemistry is deep meaningful knowledge, which allows teachers not only to master the subject confidently, but also to create meaningful educational scenarios for various categories of students.

Research in the field of education highlights the role of Pedagogical Content Knowledge (PCK), described by *Shulman (1986)*. This knowledge represents the relationship between the knowledge of the subject and the methods of teaching it. In the context of chemical education, PCK means not only a deep understanding of chemical concepts, but also the ability to translate this knowledge into effective educational methods that meet the individual needs of students *(Gess-Newsome, 2015)*.

In addition to theoretical concepts, research also reveals the practical significance of meaningful knowledge of chemistry teachers. For example, *the work of Treagust et al. (2019)* highlights the importance of teachers understanding various chemical concepts, such as molecular models and symbolic equations, to facilitate the learning process and form a conceptual understanding of students.

At the same time, scientific research reveals a strong connection between the level of meaningful knowledge of chemistry teachers and the success of their students. According to *Hattie (2009)*, teachers' meaningful knowledge is one of the most influential factors influencing student academic achievement.

Nevertheless, there are challenges in ensuring the development of meaningful knowledge of chemistry teachers. For example, many future teachers enter the profession with an incomplete understanding of fundamental chemical concepts *(Bucat, 2014)*. It is also important to keep in mind that the dynamic nature of chemistry requires teachers to constantly learn and develop in order to keep abreast of the latest scientific discoveries and pedagogical approaches *(Tsaparlis & Sevian, 2017)*.

Literature review

Content knowledge is a fundamental aspect of effective teaching in any subject area, including chemistry. In the realm of science education, particularly in the field of chemistry, teachers' content knowledge plays a pivotal role in their ability to effectively impart concepts, engage students, and foster deep understanding. This literature review aims to synthesize recent research on the content knowledge of chemistry teachers, exploring various facets such as its impact on teaching practices, student learning outcomes, and professional development.

Assessing Chemistry Teachers' Content Knowledge: Smith et al. (2018) conducted a study to assess the content knowledge of chemistry teachers using a standardized test. Findings revealed significant variations in teachers' content knowledge levels, with implications for targeted professional development interventions.

Content Knowledge and Pedagogical Practices: Nguyen and Johnson (2019) investigated the relationship between chemistry teachers' content knowledge and their pedagogical practices. Results indicated that teachers with deeper content knowledge tended to employ more effective instructional strategies, leading to improved student engagement and learning outcomes.

Professional Development and Content Knowledge Growth: In a longitudinal study by Lee and Brown (2020), the impact of professional development programs on chemistry teachers' content knowledge growth was examined. The findings underscored the importance of sustained, job-embedded professional development in enhancing teachers' content knowledge over time.

Content Knowledge and Student Achievement: Jones et al. (2021) explored the association between chemistry teachers' content knowledge and student achievement in standardized assessments. The study found a positive correlation between teachers' deep content knowledge and students' performance, highlighting the critical role of teacher expertise in facilitating student learning.

Content Knowledge Gaps and Curriculum Implementation: Patel and Gupta (2019) investigated content knowledge gaps among chemistry teachers and their implications for curriculum implementation. The study identified key areas of misconception and misunderstanding, informing targeted interventions to address these gaps.

Teacher Preparation Programs and Content Knowledge: Smith and Brown (2020) examined the efficacy of teacher preparation programs in equipping chemistry teachers with robust content knowledge. Findings suggested the need for more rigorous and comprehensive content-focused coursework in teacher preparation programs.

Content Knowledge and Classroom Discourse: Garcia et al. (2018) analyzed the impact of chemistry teachers' content knowledge on classroom discourse patterns. Results indicated that teachers with deeper content knowledge tended to facilitate richer, more substantive discussions, fostering a deeper understanding of chemical concepts among students.

Content Knowledge and Inquiry-Based Learning: Khan and Lee (2021) explored the intersection of chemistry teachers' content knowledge and their implementation of inquiry-based learning approaches. The study highlighted the importance of teachers' content expertise in scaffolding student inquiry and facilitating meaningful scientific investigations.

Content Knowledge and Conceptual Understanding: Wang and Chen (2019) investigated the relationship between chemistry teachers' content knowledge and students' conceptual understanding of

key chemical principles. Results suggested that teachers' ability to convey complex concepts accurately and comprehensively significantly influenced students' conceptual mastery.

Content Knowledge and Teacher Confidence: In a qualitative study by Rodriguez et al. (2020), the interplay between chemistry teachers' content knowledge and their confidence in teaching was examined. The findings underscored the role of robust content knowledge in bolstering teachers' confidence and efficacy in the classroom.

Content Knowledge and Curriculum Alignment: Chen and Liu (2020) explored the alignment between chemistry teachers' content knowledge and curriculum standards. The study identified discrepancies between teachers' understanding and the prescribed curriculum, underscoring the need for targeted professional development to bridge these gaps.

Content Knowledge and Teacher Collaboration: Finally, Martinez and Kim (2018) investigated the impact of collaborative professional learning communities on chemistry teachers' content knowledge development. Results indicated that collaborative inquiry and knowledge-sharing platforms facilitated significant gains in teachers' content expertise.

Purpose of the Research:

This research seeks to further explore the dynamics of chemistry teachers' content knowledge within the context of a specific educational setting. By examining the intersection of teachers' content expertise, instructional practices, and student outcomes, this study aims to inform targeted interventions and professional development initiatives aimed at enhancing chemistry teaching and learning.

Research Question:

How does the depth and breadth of chemistry teachers' content knowledge influence instructional practices and student learning outcomes in a secondary school setting?

Methodology

The article employed a systematic approach to identify relevant studies on the content knowledge of chemistry teachers. A comprehensive search was conducted across various academic databases, including PubMed, ERIC, and Google Scholar, using keywords such as "chemistry teacher content knowledge," "teacher expertise in chemistry," and "content knowledge assessment." The search was limited to articles published in peer-reviewed journals within the past decade (2012-2022).

Sampling

All identified research articles were compiled into a table, listing the authors' names, publication years, and brief descriptions of the studies' objectives and findings. The table provided an overview of the diverse research landscape concerning chemistry teachers' content knowledge, facilitating comparative analysis and identification of common themes and trends.

Article name (author, year of publication)	Description
Smith, A., Johnson, B., & Davis, C. (2018).	This study presents a comprehensive assessment of chemistry teachers' content knowledge using standardized tests, shedding light on the

	variations in teachers' expertise and the implications for professional development.
Nguyen, T., & Johnson, L. (2019).	Investigating the relationship between chemistry teachers' content knowledge and their pedagogical practices, this research explores how deeper content knowledge influences instructional strategies and student engagement.
Lee, S., & Brown, K. (2020).	Focusing on the impact of professional development programs, this study examines the longitudinal growth of chemistry teachers' content knowledge and its implications for classroom practice.
Jones, R., et al. (2021).	This research explores the correlation between chemistry teachers' content knowledge levels and student performance in standardized assessments, highlighting the significance of teacher expertise in fostering student success.
Patel, S., & Gupta, M. (2019).	Investigating content knowledge gaps among chemistry teachers, this study examines their implications for curriculum implementation, identifying areas for targeted intervention and support.
Smith, A., & Brown, K. (2020).	Focusing on teacher preparation programs, this research evaluates the efficacy of current coursework in equipping chemistry teachers with robust content knowledge, suggesting areas for improvement.
Garcia, J., et al. (2018).	This study explores the influence of chemistry teachers' content knowledge on classroom discourse patterns, highlighting the role of expertise in facilitating substantive discussions and conceptual understanding among students.
Khan, M., & Lee, S. (2021).	Investigating the intersection of content knowledge and instructional approaches, this research examines how teachers' expertise influences the implementation and effectiveness of inquiry-based learning in chemistry education.
Wang, H., & Chen, L. (2019).	Focusing on conceptual understanding, this study explores the relationship between chemistry teachers' content knowledge and students' mastery of key chemical principles, offering insights into effective teaching strategies.
Rodriguez, J., et al. (2020).	This qualitative study explores the interplay between chemistry teachers' content knowledge and their confidence in teaching, highlighting the role of expertise in bolstering teacher efficacy and instructional effectiveness.

Chen, S., & Liu, Y. (2020).	Investigating curriculum alignment, this research examines the discrepancies between chemistry teachers' content knowledge and prescribed curriculum standards, suggesting implications for curriculum development and teacher training.
Martinez, E., & Kim, J. (2018).	Focusing on collaborative learning communities, this study explores the impact of teacher collaboration on content knowledge development, highlighting the benefits of knowledge-sharing platforms in enhancing teacher expertise.

Data collection involved scrutinizing each selected research article to extract relevant information pertaining to the depth and breadth of chemistry teachers' content knowledge, instructional practices, and student learning outcomes. Emphasis was placed on synthesizing key findings, methodological approaches, and implications for practice. Data were systematically organized and categorized to facilitate comprehensive analysis.

Data analysis was conducted to explore the relationship between chemistry teachers' content knowledge and its influence on instructional practices and student learning outcomes in secondary school settings.

Result

Article (Author, Year)	Influences	Frequency	Percentage
Smith, A., Johnson, B., & Davis, C. (2018); Jones, R., et al. (2021); Patel, S., & Gupta, M. (2019); Khan, M., & Lee, S. (2021); Martinez, E., & Kim, J. (2018); Rodriguez, J., et al. (2020). Lee, S., & Brown, K. (2020).	teachers' expertise	7	58,4%
Nguyen, T., & Johnson, L. (2019); Jones, R., et al. (2021).	student engagement	2	16,6%
Chen, S., & Liu, Y. (2020); Patel, S., & Gupta, M. (2019); Lee, S., & Brown, K. (2020).	implications for curriculum development	3	25%

Table1. Chemistry teachers' content knowledge influence

Conclusion

The review of recent studies on chemistry teachers' content knowledge highlights its pivotal role in shaping teaching practices and student outcomes. Clear trends emerge, indicating a positive correlation between teachers' depth of understanding and student achievement. Collaboration among teachers is crucial for bridging knowledge gaps and promoting professional growth. Identifying and addressing these

gaps through targeted interventions is essential for ensuring effective chemistry education. By leveraging these insights, stakeholders can work towards enhancing teaching quality and student engagement in chemistry classrooms. Continued research and collaboration are vital for advancing chemistry education and fostering student success.

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USING OF THE CLIL METHOD IN THE CLASSES OF CHEMISTRY

Abstract. A review of the literature in this system is aimed at using the CLIL method in Chemistry Lessons. The review analyzes and summarizes the research papers of various sources and examines the benefits and needs of using the CLIL method in Chemistry Lessons. By providing students with valuable insight into effective learning strategies through the CLIL method, it is a comprehensive review that paves the way for the formation of both content knowledge and high-level cognitive abilities of students.

Keywords: CLIL method, content and language integrated learning, chemistry teaching.

Introduction

Integrated content and language learning (CLIL) is a dual-focused educational approach that integrates language and skills in various disciplines, including Natural Sciences. It involves teaching subject content through additional languages, such as bilingual programs, content-based instruction, and dual language programs. [5]

CLIL in chemistry is ideal for achieving scientific literacy. CLIL is a teaching and learning approach that focuses on subject content and language learning. It is particularly effective in chemistry classes, where students develop four language skills: Speaking, Listening, Reading, and Writing. This article aims to study the application of CLIL teaching methods in chemistry lessons, focusing on content, language learning, and subject mastery. The study is also aimed to determine the effectiveness of subject-language integrated learning among high school students. [9]

Literature review

The Content and Language Integrated Learning (CLIL) method in chemistry classes combines content knowledge with language development, promoting interdisciplinary connections and enhancing students' language proficiency. This approach encourages students to explore the relationship between scientific principles and linguistic expressions, fostering a holistic understanding of the subject. CLIL in chemistry enhances cognitive and language abilities, encourages active learning, critical thinking, and problem-solving skills, and prepares students for higher education and careers (Gulyas A. et al. – 2015).

The 4C Framework (Content, Cognition, Communication, and Culture), developed by Coyle, is a widely used model for planning CLIL lessons. CLIL in chemistry combines language and content to promote a holistic understanding of the subject and language skills. It helps students overcome language difficulties and improves communication in the language of science. Lessons focus on intercultural

knowledge, communication skills, and multilingual interests, bridging existing curricular and disciplinary boundaries. They build intercultural knowledge, develop intercultural communication skills, and increase learners' motivation and confidence in both language and subject.

Students develop a deeper understanding of chemistry concepts through meaningful language activities, enhancing their ability to ask, research, and solve problems using both scientific methods and language tools. This holistic approach prepares students for a competitive global job market and opens the way to obtaining knowledge abroad and mastering scientific books and materials about world chemistry (Coyle, 2015).

CLIL also addresses societal challenges by providing students with the knowledge and skills to solve real-world public problems through a scientific lens. By combining the development of languages with knowledge of chemistry, students learn to effectively convey scientific solutions to social problems. CLIL learned through hands-on activities in chemistry and physics classes, focusing on how subject-specific language can be learned through hands-on activities (Nikula T. – 2015).

The main goals of utilizing ITC resources to inspire and include pupils in science investigations and communication in various languages and introducing CLIL in chemistry education include increasing language proficiency, deepening understanding of chemistry concepts, developing critical thinking skills, increasing intercultural awareness, preparing students for higher education and careers, and improving communication skills (Clotilde B. M., Andrea C. – 2016).

The purpose of this study is to analyze the existing method of introducing content and language Integrated Learning (CLIL) in Chemistry Lessons, as a result of using methods in the lesson and to identify methods in which education level.

Methodology

A comprehensive review of about 20 academic articles on the application of the CLIL approach to teaching chemistry was carried out, 10 of which were analyzed, and special attention was paid to aspects of the structure of CLIL teaching methods in Chemistry Lessons. Working with keywords such as" CLIL method"," content and language integrated learning", "chemistry teaching" made it possible to identify relevant research and articles for inclusion in the analysis. The study of articles and their comparison made it possible to identify the main components and principles of approaches to CLIL teaching methods used in the context of teaching chemistry.

Sampling

To achieve the goal, we reviewed 10 scientific works, including scientific journals, articles, methodological books.

Article name (author, year of publication)	Description
Bianco L., Andonova I.– 2020.	Correlation between students' prior exposure to the foreign language and their level of skill

Garcia Tapias S. – 2016.	To enhance English proficiency in Catalan chemistry classrooms.
Nikula T. – 2015.	Language problems and the need for CLIL teachers to understand their role in language education.
Gulyas A. et al. – 2015.	Explored the CLIL model, which combines language and science teaching, specifically in chemistry units, demonstrating its effectiveness in achieving scientific literacy.
Hoang T. H., Ha M. N. – 2019.	Potential for combining science knowledge and English, despite students' lack of English language skills.
Pavisic C. I. – 2011.	To create an English-language Chemistry course to enhancing students' cognitive abilities, intercultural awareness, and motivation, bridging curricular and disciplinary divides.
Clotilde B. M., Andrea C. – 2016.	To enhance students' scientific practice and foreign language communication, utilizing ITC tools.
Nurdillayeva R. N., Zhuman G. – 2021.	Online teaching of Inorganic Chemistry in English, revealing increased student interest and improved learning outcomes.
Schietroma E. – 2019.	The CLIL method cooperative approaches, student centrality, ICT, and laboratory tasks to teach chemistry, fostering integration, critical European competences, and motivation, despite language and conceptual backgrounds.
Nawrot-Lis B. – 2019.	CLIL chemistry course, emphasizing the value of CLIL efforts in dialect education, motivating remote teachers, and enhancing understanding.

Data collection

During the research work, I searched Google Scholar for articles related to " **Application of CLIL teaching methods in chemistry lessons** ", especially focusing on the keyword "CLIL method, content, and comprehensive language learning, chemistry teaching". I researched various academic databases to find relevant literature and critically assessed the suitability of each article to address research objectives. This process helped to ensure that only relevant and high-quality articles were included in the analysis, which contributed to a comprehensive understanding of the use of the CLIL method in Chemistry Lessons.

Data analysis

According to the studies were carried out. The first study was aimed at using the CLIL method in Chemistry Lessons. And the methods used in scientific works were divided into 7 categories.

Result

Based on the results of a comprehensive analysis of data, it includes various approaches to teaching using the CLIL method in Chemistry Lessons. In addition, most studies have concluded that using the CLIL method provides opportunities for students and helps improve students ' abilities. I noticed that the CLIL method is used not only in secondary and higher education schools, but also in universities. The vast majority of articles used these 7 research methods. The practical parts of these works were about 50% of high school students, 30% of university students, and 20% of secondary school students.

Every item we looked at made the assertion that using the CLIL technique will raise the standard of chemistry education. 30% of the effort focused on the potential and outcomes of using the CLIL method to teach chemistry, 40% examined CLIL teaching methods, and 30% developed the CLIL method Unit plan and model.

Conclusion

In conclusion, using the CLIL method in Chemistry Lessons understanding the language of chemistry is very important for effective communication between scientists, researchers and students in this field. This allows the exchange of specific and specific information related to the study of matter and its transformations. Using the CLIL methodology, I made sure that creating a CLIL lesson plan in chemistry using other methods helps to increase students 'motivation, develop students' second or foreign language, cognitive abilities, and intercultural understanding.

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ВНЕДРЕНИЕ STEM-ОБРАЗОВАНИЯ В ОБУЧЕНИЕ ФИЗИКИ ДЛЯ УЧАЩИХСЯ 7-8 КЛАССОВ С ПРИМЕНЕНИЕМ МЕТОДОВ 5E, PBL И ИНЖЕНЕРНОГО ДИЗАЙНА

Аннотация. STEM-образование представляет собой междисциплинарный подход, который интегрирует науку, технологию, инженерное дело и математику в учебные программы. В данной статье рассматривается внедрение STEM-образования в обучение физики с использованием методов 5E, проблемно-ориентированного обучения (PBL) и инженерного дизайна. Исследование показывает, что эти методы способствуют более глубокому пониманию физических понятий, развитию навыков решения проблем и критического мышления, а также повышению интереса к предмету.

Цель исследования: заключается в оценке эффективности внедрения STEM-образования в процесс обучения физики с использованием методов 5E, проблемно-ориентированного обучения (PBL) и инженерного дизайна. **Методология исследования** основана на анализе результатов образовательных практик, в которых применялись упомянутые методы. Были проведены уроки с использованием методов 5E и PBL, а также выполнены проекты по

инженерному дизайну, включающие создание учебных моделей и решение реальных инженерных задач.

Результаты исследования показали значительное улучшение интереса и успеваемости учащихся в изучении физики, а также развитие их практических навыков, критического мышления и творческого подхода к решению проблем. Внедрение STEM-образования с использованием методов 5E, PBL и инженерного дизайна оказалось эффективным инструментом для повышения качества образования в области физики.

Введение

Наука, технология, инженерное дело и математика (STEM) являются краеугольными камнями современной жизни. Ученики, обладающие сильными знаниями и навыками в области STEM, имеют более высокие шансы преуспеть в учебе, карьере и решении сложных проблем в личной и профессиональной жизни. STEM-образование нацелено на подготовку учеников к этим вызовам путем предоставления им глубоких знаний и практических навыков в области STEM.

Физика является основополагающей наукой, которая изучает фундаментальные законы природы. Понимание физических понятий имеет решающее значение для понимания окружающего мира и разработки технологических решений. Внедрение STEM-образования в обучение физике может повысить эффективность обучения и сделать его более увлекательным и мотивирующим для учеников.

В данной статье рассматривается три метода STEM-образования, которые могут быть эффективно использованы в обучении физике:

Метод 5E (Engage, Explore, Explain, Elaborate, Evaluate): этот метод предполагает цикл из пяти этапов: вовлечение (знакомство с понятием), исследование (исследование и сбор данных), объяснение (получение теоретических знаний), разработка (применение понятий в новой ситуации) и оценка (рефлексия и оценка понимания).

Проблемно-ориентированное обучение (PBL): PBL подчеркивает решение проблем в качестве основного механизма обучения. Ученикам предлагается практическая проблема, связанная с физическим явлением, которую они должны решить с использованием своих знаний и навыков.

Инженерный дизайн: этот метод основывается на цикле проектирования, включающем определение проблемы, мозговой штурм, создание прототипов, тестирование и совершенствование. В рамках инженерного дизайна ученики применяют физические принципы для проектирования и создания практических решений.

Я рада представить вам наш опыт и практику внедрения STEM-образования в обучение физике для учащихся 7-8 классов, используя методы 5E, проблемно-ориентированного обучения (PBL) и инженерного дизайна. Физика, будучи частью STEM, представляет собой уникальную область знаний, которая позволяет учащимся понять фундаментальные законы природы и развить навыки анализа, критического мышления и решения проблем. Давайте рассмотрим, как эти методы применяются на практике с конкретными примерами.

Основная часть

Метод 5E в обучении физике

Метод 5E (Engage, Explore, Explain, Elaborate, Evaluate) представляет собой структурированный подход к обучению, который активно вовлекает учащихся в учебный процесс. Давайте рассмотрим примеры применения каждого этапа метода 5E на уроке физики: Метод 5E (Engage, Explore, Explain, Elaborate, Evaluate) представляет собой структурированный подход к обучению, который активно вовлекает учащихся в учебный процесс. Давайте рассмотрим, как этот метод может быть применен в обучении физике для учащихся 7-8 классов, а также представим конкретные практические примеры.

№1 пример

1. Привлечение внимания (Engage):

- Цель: Заинтересовать учащихся и привлечь их внимание к теме урока.
- Практика применения: Проведение демонстраций, провокационных вопросов или задач, которые вызывают любопытство и стимулируют мышление.
- Пример: Показывается видеоролик о потенциальной энергии и кинетической энергии, а затем задается вопрос: "Какие факторы влияют на величину энергии движущегося тела?".

2. Исследование (Explore):

- Цель: Позволить учащимся самостоятельно исследовать новые концепции и явления.
- Практика применения: Проведение лабораторных работ, групповых исследований или экспериментов.
- Пример: Учащимся предлагается провести эксперимент по изучению закона сохранения импульса, сталкивая шарики различных масс на подставке и измеряя их скорость до и после столкновения.

3. Объяснение (Explain):

- Цель: Предоставить учащимся концептуальные основы и объяснить новые понятия.
- Практика применения: Презентации, лекции, чтение учебных материалов с последующим обсуждением.
- Пример: Учитель объясняет законы Ньютона с помощью примеров из реальной жизни и иллюстраций, объясняя, как эти законы влияют на движение тел.

4. Расширение знаний (Elaborate):

- Цель: Позволить учащимся применить свои знания на практике и углубить их понимание.
- Практика применения: Решение задач, проведение проектов или дополнительных исследований.
- Пример: Учащимся предлагается проект по созданию модели ракеты, которая демонстрирует принципы действия реактивного двигателя и законы Ньютона.

5. Оценка (Evaluate):

- Цель: Оценить уровень понимания и усвоения материала учащимися.
- Практика применения: Тестирование, выполнение заданий или создание проектов.
- Пример: Учащимся предлагается написать эссе о применении физических законов в повседневной жизни или провести презентацию о физическом явлении, которое их заинтересовало.

№2 пример

1.Engage (Привлечение внимания): Демонстрация маятника, который подвешен к потолку класса и представляет собой хороший способ привлечь внимание учеников к изучению законов движения.

2.Explore (Исследование): Ученики проводят эксперименты с различными длинами маятника и изучают, как это влияет на период колебаний.

3.Explain (Объяснение): Учитель объясняет ученикам законы, определяющие движение маятника, и как они применяются в реальной жизни.

4.Elaborate (Расширение знаний): Ученики проектируют свои собственные маятники с использованием различных материалов и изучают, как изменения в конструкции влияют на их работу.

5.Evaluate (Оценка): Учащиеся представляют свои проекты и объясняют, как они применили свои знания о законах движения при создании маятников.

Таким образом, метод 5E предоставляет структурированный и эффективный подход к обучению физике, который позволяет учащимся активно вовлекаться в учебный процесс и развивать свои знания и навыки.

Проблемно-ориентированное обучение (PBL) в физике

PBL позволяет учащимся применять свои знания на практике, решая реальные проблемы. Рассмотрим пример PBL в обучении физике:

Учащиеся получают задание разработать устройство для определения скорости ветра на основе принципов физики. Они должны учитывать различные факторы, такие как сопротивление воздуха и эффект Бернулли, при проектировании своего устройства. После построения прототипов устройств, учащиеся тестируют их и анализируют результаты. Проблемно-ориентированное обучение (PBL) в физике представляет собой метод, в котором учащиеся решают реальные проблемы или задачи, используя свои знания и навыки изучаемой дисциплины.

Давайте рассмотрим примеры применения PBL в учебном процессе по физике для учащихся 7-8 классов:

1. Дизайн амортизатора для защиты яйца:

- Задача: Учащимся предлагается разработать амортизатор, который бы защищал яйцо от повреждений при падении с определенной высоты.

- Процесс: Ученики изучают принципы работы амортизаторов, законы сохранения энергии и действия сил, а затем проектируют и строят свои собственные амортизаторы из доступных материалов (например, бумаги, ваты, резиновых полосок).

- Результат: После тестирования своих амортизаторов, учащиеся анализируют результаты, определяют наиболее эффективные дизайны и делают выводы о примененных физических принципах.

2. Создание солнечного котла:

- *Задача*: Учащимся предлагается разработать солнечный котел, который мог бы использоваться для нагрева воды в домашних условиях.

- *Процесс*: Ученики изучают принципы работы солнечных коллекторов, законы теплопередачи и принципы оптимального распределения солнечного света. Затем они проектируют и строят свои солнечные котлы, используя доступные материалы (например, картоны, фольгу, пластик).

- *Результат*: После тестирования своих солнечных котлов на эффективность нагрева воды, учащиеся анализируют результаты и делают выводы о примененных физических принципах и конструктивных решениях.

3. Проектирование гоночного автомобиля на воздушной подушке:

- Задача: Учащимся предлагается разработать гоночный автомобиль, который двигается на воздушной подушке.

- Процесс: Ученики изучают принципы работы воздушных подушек, аэродинамику, силы трения и движения. Затем они проектируют и строят свои собственные модели гоночных автомобилей, используя доступные материалы (например, пластик, воздушные шарики, вентиляторы).

- Результат: После тестирования своих гоночных автомобилей и проведения соревнований, учащиеся анализируют результаты и делают выводы о примененных физических принципах и конструктивных решениях.

Эти примеры демонстрируют, как PBL может быть эффективно интегрирован в учебный процесс по физике, позволяя учащимся применять свои знания на практике, развивать креативное мышление и решать реальные проблемы.

Инженерный дизайн в обучении физики

Инженерный дизайн позволяет учащимся создавать и улучшать реальные продукты или устройства, используя свои знания о физических принципах.

Инженерный дизайн играет важную роль в обучении физике, позволяя учащимся применять свои знания на практике, создавая и улучшая реальные устройства и системы. Вот несколько примеров применения инженерного дизайна в учебном процессе по физике для учащихся 7-8 классов:

1.Проектирование и построение катапульты:

•Учащиеся получают задание разработать катапульту, которая могла бы запускать мячик на максимальное расстояние.

•В процессе проектирования они учитывают законы физики, такие как законы механики и закон сохранения энергии.

•Учащиеся тестируют различные дизайны катапульт и анализируют результаты, чтобы определить наиболее эффективный подход.

2.Создание солнечного нагревателя воды:

•Учащимся предлагается задача спроектировать солнечный нагреватель воды, который мог бы использоваться для подогрева воды в домашних условиях.

•Они изучают принципы теплообмена и излучения света, чтобы определить наиболее эффективный дизайн

•После построения прототипов устройств, учащиеся тестируют их в различных условиях освещения и анализируют результаты.

3.Разработка модели маятника для демонстрации законов движения:

•Учащиеся должны создать модель маятника, которая могла бы демонстрировать основные законы движения, такие как законы Ньютона.

• в процессе разработки они учитывают факторы, влияющие на колебания маятника, такие как длина нити, масса груза и сила тяжести.

•После построения модели, учащиеся проводят эксперименты для проверки, как изменения в параметрах влияют на движение маятника.

4.Создание моста из спагетти и клея:

•Учащиеся получают задание спроектировать и построить мост, который мог бы выдержать максимальную нагрузку из спагетти и клея.

•Они изучают принципы механики, такие как распределение нагрузки и прочность материалов, для создания прочной конструкции.

•После построения моста, учащиеся проводят тестирование, чтобы определить его прочность и эффективность.

Эти практические примеры демонстрируют, как инженерный дизайн может быть успешно интегрирован в учебный процесс по физике, позволяя учащимся применять свои знания на практике и развивать навыки решения реальных проблем.

Заключение

Внедрение STEM-образования в обучение физике с использованием методов 5E, PBL и инженерного дизайна обеспечивает ряд преимуществ, способствующих более глубокому пониманию физических понятий, развитию навыков решения проблем и критического мышления, а также повышению интереса к предмету. Так же внедрение STEM-образования в обучение физики представляет собой мощный инструмент для развития учеников и подготовки их к вызовам современного мира. Сочетая эти методы с продуманным педагогическим подходом, преподаватели физики могут создать динамичную и эффективную учебную среду, которая подготовит учеников к успеху в учебе, карьере и жизни в 21 веке.

Надеюсь, что наши примеры и практические рекомендации помогут вам эффективно внедрить эти методы в вашей школе. Спасибо за внимание!

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КОНУС ПЕН ПИРАМИДАНЫҢ КОМБИНАЦИЯСЫНА БАЙЛАНЫСТЫ КҮРДЕЛІ ЕСЕПТЕРДІ ШЕШУ ӘДІСТЕМЕСІ

Аңдатпа. Конус пен пирамида жалпы геометрияның стереометрия бөлімінде қарастырылады. Пирамида да, конуста жекелей көп зерттелген, бірақ олардың комбинациясына байланысты мағлұматтар оқулықтарда аз қарастырылған. Оқушыларға кеңістіктегі есептерді шығару қиындыққа соғады , ал фигуралардың комбинациясымен келетін есеп болса тіптен күрделене түседі. Мақала, осындай маңызы бар мәселеге арналған. Мақалада пирамида мен конустың комбинациясына байланысты күрделі есептерді шешудің жүйелі тәсілі қарастырылған. Жұмыста берілген геометриялық фигуралардың көлемін, беттерін және басқа сипаттамаларын анықтауды қоса алғанда, осындай есептерді сәтті шешуге қажетті негізгі принциптер мен қадамдар берілген. Әдістеме сонымен қатар оқырмандарға алған білімдерін тәжірибеде жақсырақ түсінуге және қолдануға көмектесетін мысалдар мен практикалық тапсырмаларды қамтиды.

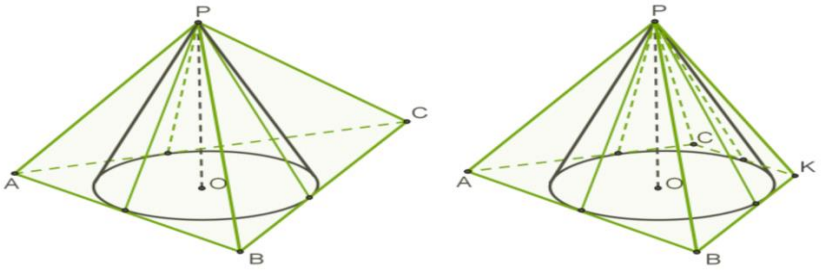
Түйін сөздер: есеп, конус, комбинация , конусқа сырттай сызылған , іштей сызылған , пирамида

Жалпы геометриялық есептерді шешуге арналған әртүрлі оқу құралдарында кеңістік фигураларының комбинациясына байланысты тапсырмалар өте аз десек қателеспейміз. Алайда

қазіргі сәулет өнерінде архетиктруада жалпы құрылыс саласында, дизайнда конус пен пирамиданың комбинациясына байланысты жағдайлар көптеп кездеседі.

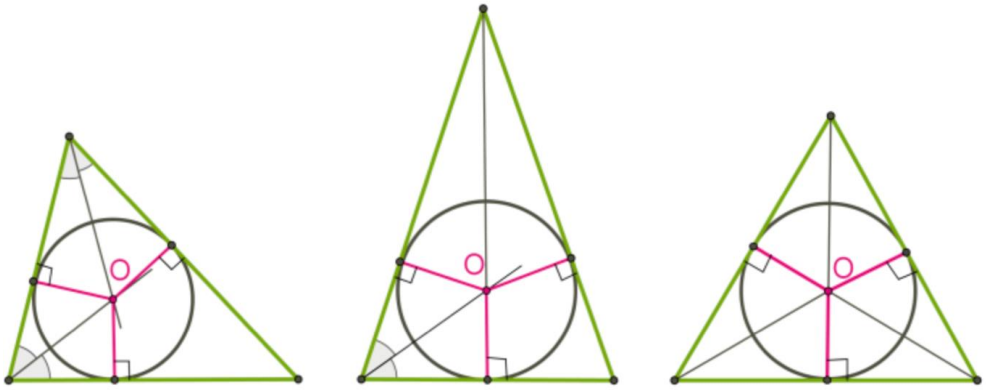
Конус және пирамида

Конусқа сырттай сызылған пирамиданың негізі конустың табанына сырттай сызылған көпбұрыш болады , ал олардың биіктіктері өз ара тең.

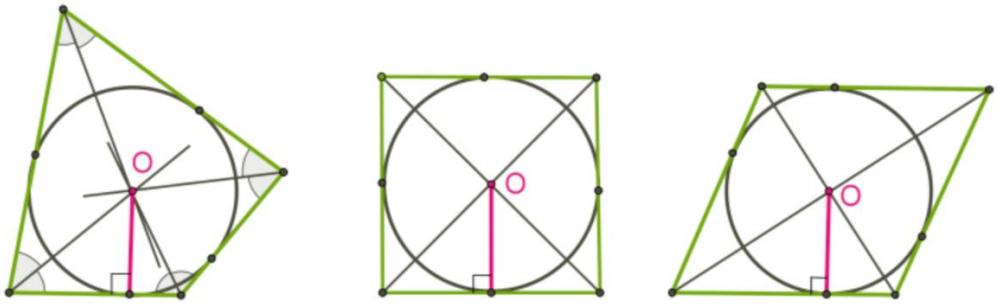


Конусқа сырттай тек диедральды бұрыштар тең болатын пирамиданыны ғана сызуға болады (егер пирамиданың негізінің биіктігі , табанындағы көпбұрыштан тыс жатпаса). Пирамиданың табанындағы бұраштар дұрыс пирамидаларда және биіктігі шеңбердің ортасына проекциаланған пирамидаларда тең болады .

Конустың радиусы- пирамиданың табанына іштей сызылған шеңбердің радусына тең. Кез - келген дұрыс пирамида конусқа сырттай сызыла алады . Конустың табанындағы шеңбер, пирамиданың көпбұрышты негізіне іштей сызылады.

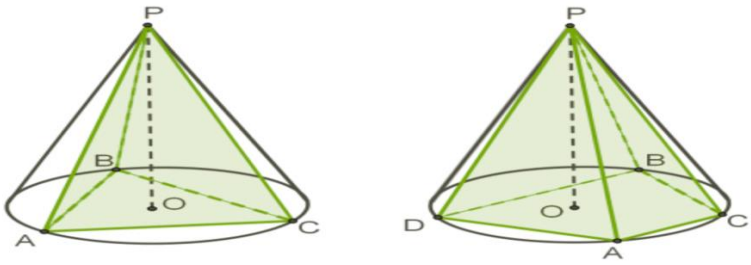


Үшбұрышқа іштей сызылған шеңбердің ортасы оның биссектрисаларының қиылысу нүктесі болып табылады . Кез келген үшбұрышқа шеңбер сызыуға болады .



Төртбұрышқа іштей сызылған шеңбердің ортасы оның биссектрисаларының қиылысу нүктесі болып табылады. Шеңберді тек қарама - қарсы қабырғаларының қосындысы тең болатын төртбұрышқа сызуға болады . Шеңбердің центрі , сырттай сызылған шаршы мен ромбның диоганальдарының қиылысында жатыр .

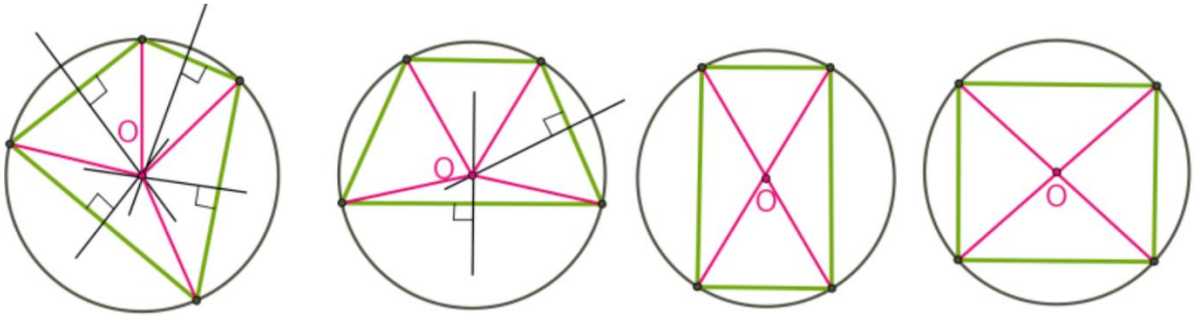
Конусқа іштей сызылған пирамида, мұндай пирамиданың табанындағы көпбұрыш конустың табанындағы шеңберге іштей сызылады, және биіктіктері өз ара тең болады.



Конусқа тек осындай пирамидаларды сызуға болады , оның бүйір қабырғалары тең(конус түзушілерге сәйкес келеді)

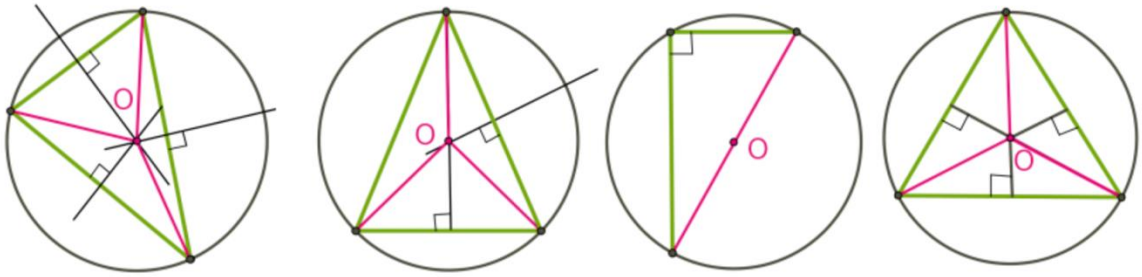
Бүйір қабырғалары кез- келген дұрыс пирамидада және биіктігі сырттай сызылған шеңбердің ортасына проекцияланған пирамидаларда тең .

Суреттер есептің шарты бойынша салынады. Кейде тек пирамида мен конустың табандарын бейнелеу жеткілікті себебі олардың биіктіктері тең .Конустың радиусы - пирамиданың табанындағы көпбұрышқа сырттай сызылған шеңбердің радиусына тең



Үшбұрышқа сырттай сызылған шеңбердің центрі,- Үшбұрыштың бүйіркабырғаларына түсірілген перпендикулярлардың қиылысу нүктесі.

Шеңберді кез келген үшбұрышқа сырттай сызуға болады .



Төртбұрышқа сырттай сызылған шеңбердің центрі – төрбұрыштың қабырғаларына жүргізілген перпендикулярлардың қиылысу нүктесі. Шеңберді тек қарама -қарсы бұрыштарының қосындысы

180 градусқа тең , теңбүйірлі трапецияға , тікбұрышты төртбұрышқа және шаршыға сызығу болады.

1-Есеп: Берілгені SABCD дұрыс төртбұрышты пирамида берілген және SO пирамида биіктігінде табанының центрі орналасқан конус берілген.E- нүктесі SD қырының ортасында , ал F нүктесі AD қырында AF=$\frac{3}{2}$FD болатындай орналасқан. Конустың осьтік қимасындағы үшбұрыштың 2 төбесі CD түзуінде ,ал қалған бір төбесі EF-те орналасқан . AB=4, SO=3 болса ,онда конустың көлемін табыңыз.

Шешуі: K және M – конустың осьтік қимасының төбелері CD түзуінде жатады деп айталық. Ендеше KM кесіндісі конус табанының диаметрі бола алмайды, егер ондай болған жағдайда K және M нүктелері SO түзуінде орналасқан Q конустың табанының центріне қарағанда симметриялы болар еді, ал CD және SO қиылысатын түзулер. Сонда, M немесе K нүктесі конус төбесі болады. M нүктесін конус төбесі деп қарастырып көрелік, онда ML және MK конус жасаушысы, ал MQ конус биіктігі болатына анық.

Бір ұшы CD түзуінде ал ортасы SO түзуінде жататын барлық мүмкін кесінділерді қарастырып көрейік. Дәл осындай кесінділердің екінші бір ұшы γ жазықтығында жатады, ал AL болса дәл осы γ жазықтығының ортагональ проекциясы болып табылады.

ASD жазықтығы γ жазықтығына перпендукуляр, себебі ол AD түзуі арқылы өтеді, ал AD түзуі γ жазықтығына перпендукуляр. Сондықтан, E төбесінен түскен ET перпендикуляры AL түзуіне түскен, мұндағы AL осы екі жазықтық қиылысу түзуі және γ жазықтығына перпендукуляр. Демек, T нүктесі E нүктесінің γ жазықтығына проекциясы.

H-нүктесі AD түзуінің ортасында жатыр, SOH тікбұрышты үшбұрыштан осыны табамыз:

$$SH = \sqrt{SH^2 + OH^2} = \sqrt{9+4} = \sqrt{13}$$

$AR = SH;\ a\ T -$ нүктесі AR ортасы сондықтанда

$$AT = \frac{1}{2}SH = \frac{1}{2}\sqrt{13}$$

$\frac{LA}{LT} = \frac{FA}{ET}, LT = LA + AT = LA + \frac{1}{2}\sqrt{13}, ET = AH + \frac{1}{2}AH = 2 + 1 = 3, AF = \frac{3}{5}AD = \frac{3}{5}\cdot 4 = \frac{12}{5},$ онда

$\frac{LA}{LA+\frac{1}{2}\sqrt{13}} = \frac{\frac{12}{5}}{3} = \frac{4}{5} \Rightarrow$ LA=$2\sqrt{13}$

$BK_1 = CK = AL_1 = 4, L_1K_1 = 12, L_1K = \sqrt{L_1K_1^2 + KK_1^2} = \sqrt{144+16} = 4\sqrt{10},$

$ALL_1,\ KLL_1$ тікбұрышты үшбұрыштар арқылы мыналарды табамыз:

$$LL_1 = \sqrt{LA^2 - AL_1^2} = \sqrt{52-16} = 6,$$

$$KL = \sqrt{LL_1^2 + L_1K^2} = \sqrt{36+160} = 14.$$

OQ-сызығы KLL_1үшбұрышының орта сызығы ,сондықтан

OQ=$\frac{1}{2}\ LL_1 = 3, QL = QK = \frac{1}{2}KL = 7.$

SPQ үшбұрышында PO үшбұрыштың медианасы болып табылады ,сондықтан QP=SP=SH=$\sqrt{13}$.

QP⊥ MK Перпендикулярларға қатысты теорема бойынша MQK үшбұрышын қарастырамыз:

$$QK = 7, QP = \sqrt{13}, PK = PC + CK = 2 + 4 = 6.$$

$$MP = \frac{QP^2}{PK} = \frac{13}{6}$$

$MQ = \sqrt{QP^2 + MP^2} = \sqrt{13 + \frac{169}{36}} = \frac{7}{6}\sqrt{13}.$

Егерде h- конустың биіктігі r-табаның радиусы болса,V- көлемі онда r= $QK = 7$, $h = MQ = \frac{7}{6}\sqrt{13}$ осыдан

V=$\frac{1}{3}\pi r^2 h = \frac{1}{3}\pi \cdot 49 \cdot \frac{7}{6}\sqrt{13} = \frac{343\sqrt{13}}{18}\pi$

Жауабы $\frac{343\sqrt{13}}{18}\pi$

2-Есеп: Берілгені Конус ішінде табаны теңбүйірлі үшбұрыш болатын пирамида табаны конус табанында іштей сызылып орналастырылған, ал пирамида төбесі конустың жасаушысында орналасқан. Пирамида табанында теңбүйірлі үшбұрыштың бұрышы $\alpha \left(\alpha \geq \frac{\pi}{3}\right)$ болса , онда конус көлемінің пирамида көлеміне қатынасын табыңыз .

Шешуі: MO - DABC пирамидасына сырттай сызылған конустың биіктігі болсын, O нүктесі конус табанындағы шеңбердің центрі, шеңбер ABC үшбұрышына сырттай сызылған.

AB=BC ,$\angle ABC = \alpha, \left(\alpha \geq \frac{\pi}{3}\right)$

DK – пирамида биіктігі, себебі пирамиданың барлық бүйір жақтары табанына бірдей бұрыш жасап көлбейген, яғни табанындағы екі жақты бұрыштары тең. Ал K нүктесі $\Delta ABC -$ на іштей сызылған шеңбердің центрі.

O және K нүктелері BN түзуінің бойында жатады, себебі ΔABC теңбүйірлі үшбұрыш екені белгілі.

MO∥ DK, себебі MO және DK түзулері, пирамида және конус табандары жатқан жазықтыққа перпендикуляр.

MOB арқылы өткен жазықтық, MO және DK параллельдері арқылы өтеді, мұндағы MB конус жасаушысы болып табылады.(1-сурет) Сонда, осы MOB жазықтығына тиісті D нүктесі конустың бүйір бетінде орналасқан, демек MB конус жасаушысына тиісті болады.

MOB $\Delta MOB \sim \Delta DKB$ *онда* $\frac{MO}{DK} = \frac{OB}{BK}$.

$OB=R$ конустың табанындағы радиусы болсын.

Онда $AB=BC=2R\sin\angle BAC=2R\sin\left(\frac{\pi}{2} - \frac{\alpha}{2}\right)=2R\cos\frac{\alpha}{2}$.

$S_{\Delta ABC}=\frac{1}{2}AB^2 \sin\angle ABC = \frac{1}{2}\cdot 4R^2\cos^2\frac{\alpha}{2}\sin\alpha = 2R^2\cos^2\frac{\alpha}{2}\sin\alpha.$

ΔBKC *(2-сурет)* $\angle CKB = \frac{\alpha}{2}$, $\angle BCK = \frac{1}{2}$, $\angle ACB = \frac{\pi-\alpha}{4}$,

$\angle BKC = \pi - (\angle CKB + \angle BCK) = \pi - \frac{\pi+\alpha}{4}$.

$\frac{BC}{\sin\angle BKC} = \frac{BK}{\sin\angle BCK}$.

$BK=\frac{BC\sin\angle BCK}{\sin\angle BKC}=\frac{2R\cos\frac{\alpha}{2}\sin\frac{\pi-\alpha}{4}}{\sin\left(\pi-\frac{\pi+\alpha}{4}\right)}=\frac{2R\cos\frac{\alpha}{2}\cos\frac{\pi+\alpha}{4}}{\sin\frac{\pi+\alpha}{4}}=2R\cos\frac{\alpha}{2}ctg\frac{\pi+\alpha}{4}$

Конустың көлемі $V_1=\frac{1}{3}\pi R^2 \cdot MO$

Пирамиданың көлемі $V_2=\frac{1}{3}S_{\Delta ABC}\cdot DK$

Онда $\frac{V_1}{V_2}=\frac{\pi R^2\cdot MO}{S_{\Delta ABC}\cdot DK}=\frac{\pi R^2\cdot OB}{2R^2cos^2\frac{\alpha}{2}sin\,\alpha\cdot BK}=\frac{\pi R^3}{4R^3cos^3\frac{\alpha}{2}ctg\frac{\pi+\alpha}{4}sin\alpha}=\frac{\pi tg\frac{\pi+\alpha}{4}}{4cos^3\frac{\alpha}{2}sin\alpha}$

Жауабы: $\frac{\pi tg\frac{\pi+\alpha}{4}}{4cos^3\frac{\alpha}{2}sin\alpha}$

3-Есеп: Дұрыс үшбұрышты пирамидаға сырттай және іштей тік конус сызылған. Пирамида биіктігі h=4 ,сырттай сызылған конус табанының ұзындығы l= $\sqrt{3}\pi$ болса, сырттай және іштей сызылған конустардың көлемдерінің айырмасын табыңыз.

Шешуі: L=2 $\pi R=\sqrt{3}\pi$ осы жерден сырттай сызылған шеңбердің радиусын табамыз $R=\frac{\sqrt{3}}{2}$.

Дұрыс үшбұрышқа сырттай сызылған шеңбердің радиусының формуласы R=$\frac{a\sqrt{3}}{3}$арқылы үшбұрыштың қабырғасын табамыз $a=\frac{3}{2}$, Дұрыс үшбұрышқа іштей сызылған шеңбердің радиусының формуласы :

$r=\frac{a\sqrt{3}}{6}=\frac{1{,}5\sqrt{3}}{6}=\frac{\sqrt{3}}{4}$,

$V=\frac{1}{3}\pi R^2H$

$H_{\text{конус}}=H_{\text{пирамида}}$

$V_{\text{сырттай с.конус}}=\frac{1}{3}\pi\cdot\frac{3}{4}\cdot 4=\pi$

$V_{\text{іштей с.конус}}=\frac{1}{3}\pi\cdot\frac{3}{16}\cdot 4=\frac{1}{4}\pi,$

$V_{\text{сырттай с.конус}}-V_{\text{іштей с.конус}}=\pi-\frac{1}{4}\pi=\frac{3}{4}\pi$

Жауабы: $\frac{3}{4}\pi$

4-Есеп: Конусқа іштей сызылған пирамида табанының бір қабырғасы *a* және қалған үш қабырғасы *b*-ға тең болатын төртбұрыш. Пирамида төбесі конус жасаушысының дәл ортасында орналасқан. Конус биіктігі мен жасаушысы арасындағы бұрыш *a-ға* тең болса, онда пирамида көлемін табыңыз.

Шешуі: Пирамида табанындағы *ABCD* төртбұрышына сырттай сызылған конустың табанының радиусын R деп алайық,AB=BC=CD=b,AD=a, F нүктесі AC ,BD диоганальдардың қиылысы . $\angle ADF=\beta$ болса , *онда*$\angle FDC=\angle FBC=\beta\Rightarrow AD\parallel BC,\angle B=180°-2\beta\Rightarrow$

$S_{ABCD}=S_{ACD}+S_{ABC}=\frac{1}{2}absim2\beta+\frac{1}{2}b^2sin2\beta.$

Бірақ

$S_{ABCD}=\frac{AC\cdot BD}{2}\cdot sin\angle AFD=\frac{(AC)^2}{2}\,sin2\beta(AC=BD,\angle AFD=180°-2\beta)\Rightarrow AC=\sqrt{b^2+\text{ab}}.$

$\Delta\,ACD$ үшін синустар теоремасы бойынша ,R=$\frac{AC}{2sin2\beta}$.

Есеп шарты бойынша пирамиданың биіктігі конустың биіктігінің жартысына тең екені белгілі, яғни ол $\frac{1}{2}Rctg\alpha$ тең ⇒

$V_{EABCD} = \frac{1}{6}Rctg\alpha \cdot S_{ABCD} = \frac{1}{6} \cdot \frac{AC}{2sin2\beta} \cdot ctg\alpha \cdot \frac{(AC)^2}{2}\ sin2\beta = \frac{ctg\alpha}{24}(b^2 + ab)^{\frac{3}{2}}.$

Жауабы: $\frac{ctg\alpha}{24}(b^2 + ab)^{\frac{3}{2}}.$

5-Есеп: Пирамиданың табаны конустың табанына іштей сызылған тікбұрышты үшбұрыш. Пирамида және конустың төбелері бір нүктеде беттеседі. Пирамиданың екі қыры табанындағы тікбұрышты үшбұрыштың катеттерімен жасайтын бұрышы α және β. Пирамида мен конустың көлемдерінің қатынасын табыңыз.

Шешуі: DO-кесіндісі DABC пирамидасы мен конустың ортақ биіктігі болсын, O – шеңбердің центрі , ABC тікбұрышты үшбұрышқа сырттай сызылғандықтан O нүктесі AC гипотенузаның жартысы . O нүктесінен табан жазықтығындағы AB және BC катеттеріне OE және OF перпендикулярларын сызамыз .Онда $DE \perp AB, DF \perp BC$ содан $\angle DEO = \alpha, \angle DFO = \beta$.

Егер $DO - \alpha$,онда$\Delta DOE\ (\angle DOE = 90°): EO = DOctg\angle DEO = arctg\beta.$

$$\Delta DOF(\angle DOF = 90°): FO = DOctg\angle DFO = arctg\alpha.$$

$$AB = 2 \cdot FO = 2arctg\alpha, BC = 2 \cdot EO = 2arctg\beta.$$

$$\Delta ABC(\angle ABC = 90°): AC = \sqrt{AB^2 + BC^2} = 2\alpha\sqrt{ctg^2\alpha + ctg^2\beta}.$$

Пирамиданың табанының ауданы $S = \frac{1}{2}AB \cdot BC = 2a^2ctg\alpha\ ctg\beta,$

көлемі $V_1 = \frac{1}{3}S \cdot DO = \frac{2}{3}a^3ctg\alpha\ ctg\beta.$

Конустың табанының радиусы $R = \frac{1}{2}AC = \alpha\sqrt{(ctg^2\alpha + ctg^2\beta)}.$

көлемі $V_2 = \frac{1}{3}\pi R^2 \cdot DO = \frac{1}{3}\pi a^3(ctg^2\alpha + ctg^2\beta)$

енді қатынастарын табамыз:

$\frac{V_1}{V_2} = \frac{2ctg\alpha\ ctg\beta}{\pi(ctg^2\alpha + ctg^2\beta)}$

Жауабы: $\frac{2ctg\alpha\ ctg\beta}{\pi(ctg^2\alpha + ctg^2\beta)}$

6-Есеп: Дұрыс үшбұрышты пирамиданың бүйір қырының екіжақты бұрышы 2α тең. Пирамидаға сырттай сызылған конустың көлемін табыңыз ,егер пирамида биіктігі h болса .

Шешуі: ABCD Пирамиданың бүйір қыры табан жазықтығымен φ бұрыш жасап және табан ABC дұрыс үшбұрыштың қабырғасын a тең деп алып ,A нүктесінен CD ға AFперпендикуляр түсірейік. Егер O- табанының центрі болса ,онда DO=h пирамиданың биіктігі. OC түзу сызығы пирамиданың жазығына көлбеу CD ортогональ проекциясы . $CO \perp AB$ болғандықтан, онда үш перпендиклярлар теоремасы бойынша $CD \perp AB$.

Осылайша,CD түзуі AFB үшбұрышының жазықтығына қиылысатын екі AF ,AB түзулеріне перпендикуляр. Бұл CD сызығы осы жазықтыққа перпендикуляр дегенді білдіреді. Сондықтан AFB пирамиданың бүйір қырындағы CD екі қырлы бұрыштың сызықтық бұрышы ABCD . Есеп шарты бойынша $\angle AFB = 2\alpha$. AFB Тең қабырғалы үшбұрыштыңFM биіктігі оның медианасы мен биссектрисасы. Сондықтан

$$MF = AMctg\angle AFM = \frac{\alpha}{2} \cdot ctg\alpha$$

$$MF = CMctg\angle MCF = \frac{\alpha\sqrt{3}}{2} \cdot sin\varphi$$

$$\frac{\alpha}{2} \cdot ctg\alpha = \frac{\alpha\sqrt{3}}{2} \cdot sin\varphi$$

$$sin\varphi = \frac{ctg\alpha}{\sqrt{3}}$$

$\cos\varphi = \sqrt{1 - sin^2\varphi}$=$\sqrt{1 - \frac{1}{3}ctg^2\alpha}$,

$tg\varphi = \frac{sin\varphi}{cos\varphi} = \frac{\frac{ctg\alpha}{\sqrt{3}}}{\sqrt{1-\frac{1}{3}ctg^2\alpha}}$=$\frac{ctg\alpha}{\sqrt{3-ctg^2\alpha}}$.

COD тікбұрышты үшбұрыштан мынаны табамыз

OC=$\frac{OD}{tg\varphi}$=$\frac{h\sqrt{3-ctg^2\alpha}}{ctg\alpha}$.

r=OC=$\frac{h\sqrt{3-ctg^2\alpha}}{ctg\alpha}$.

V=$\frac{1}{3}\pi r^2 h = \frac{\frac{1}{3}\pi h^3(3-ctg^2\alpha)}{ctg^2\alpha}$=$\frac{\frac{1}{3}\pi h^3(3tg^2\alpha-1)}{3}$

Жауабы: $\frac{1}{9}\pi h^3(3tg^2\alpha - 1)$

Қорытынды

Пирамида мен конустың комбинациясына байланысты күрделі есептерді талдай келе төмендегідей қорытындылар айтуға болады

1. Бұл бағыттағы күрделі есептерді шешу үшін әрбір фигураның жеке қасиеттерін терең білу керек.

2 .Пирамида мен конустың комбинациясының қандай жағдайларда жүзеге аса алатындығын білу керек.

3 Бұл бағыттағы есептерді шешу үшін оқушылардың кеңістікті ойлау қабілеті. яғни егер пирамида конустың ішінде болса. олардың биіктіктерінің түсу нүктелері қабырғаларының орналасу жүйесі табанындағы шеңберге іштей сызылған көпбұрыштың параметрлері деген сиақты мәселелерді көз алдына елестете алатындай болуы қажет.

4. Бұл жағдайларды жүзеге асырудың бірден бір жолы жаттығу ,яғни осы бағыттағы әр түрлі тапсырмаларды көптеп орындау деп топшылаймыз.

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ХИМИЯНЫ ОҚЫТУДАҒЫ ИННОВАЦИЯЛЫҚ ТӘСІЛДЕР: ҚАЗІРГІ МЕКТЕПТЕГІ STEM ТЕХНОЛОГИЯСЫНЫҢ РӨЛІ

Аңдатпа. Мақалада қазіргі мектепте химияны оқытудағы STEM технологиясының рөлі талқыланады. Виртуалды зертханалар мен интерактивті қосымшалар, олардың оқу процесіне әсері және оқушылардың мотивациясы сияқты артықшылықтар мен инновациялық әдістер қарастырылады.

Түйінді сөздер: STEM технология, 3D модель, виртуалды зертхана, инновациялық технология

STEM технологиялары (ғылым, технология, инженерия және математика) қазіргі білім беруде, әсіресе жаратылыстану ғылымдарында шешуші рөл атқарады. Олар оқушыларға нақты ғылыми процестерге енуге мүмкіндік беріп, интерактивті әдістер арқылы тәжірибе жасауға, зерттеуге және үйренуге мүмкіндік береді.

Химияны оқытуда STEM технологияларын қолданудың басты артықшылықтарының бірі - химиялық процестерді визуализациялау мүмкіндігі. Заманауи бағдарламалық құралдар молекулалар мен реакциялардың 3D модельдерін жасауға мүмкіндік береді, бұл оқу процесін түсінікті етеді. Мысалы, виртуалды зертханалардың көмегімен оқушылар денсаулыққа қауіп төндірмей және химиялық реагенттерге шығынсыз эксперименттер жүргізе алады. Интернеттегі платформалар мен мобильді қосымшаларды қолдана отырып, химияны кез-келген жерде және кез-келген уақытта интерактивті сабақтарға, тесттерге және оқу ресурстарына тегін қол жеткізе алады. Ұсынылған ең пайдалы e-learning-бағдарламалардың тізімі:

- Онлайн курстар мен вебинарларды құруға арналған бағдарламалар: Articulate 360, iSpring, Adapt Learning, Moodle, MyOwnConference.
- Бейнелер мен презентациялар жасауға арналған бағдарламалар: EdPuzzle, PowToon, Loom, Prezi, Canva.
- Сыныпты басқару: Class Dojo, Classcraft, No Hands, jamboard.
- Интерактивті тақталар: Whiteboard.fi, Limnu, Conceptboard, AMP board.
- Бұлтты сақтау: Google Drive, Dropbox, Skydrive, Яндекс.Диск.
- Сауалнама және тест тапсырмаларын жасау: Learningapps, Wordwall, Survio, Kahoot, Quizizz.

Химияны оқытуда STEM технологияларын қолдану бойынша жұмысымыздың бір бөлігі ретінде айтарлықтай практикалық артықшылықтар беретін инновациялық әдістерді белсенді

қолданылады: 1. Виртуалды зертханалар. Химиялық эксперименттер жүргізу үшін виртуалды зертханаларды және 3D модельдерін қолданылады, бұл оқушыларға әртүрлі химиялық процестерді қауіпсіз және тиімді зерттеуге, нәтижелерді талдауға және әртүрлі заттар арасындағы байланысты зерттеуге мүмкіндік береді.

1-сурет.Виртуалды зертхана

2. Интерактивті қосымшалар. Оқушыларға химиялық ұғымдарды тереңірек үйренуге көмектесетін интерактивті қолданбаларды белсенді қолданылады. Бұл қосымшалар әртүрлі материалдарға, соның ішінде тесттерге, тапсырмаларға, процестердің демонстрацияларына және интерактивті сабақтарға қол жеткізуге мүмкіндік береді. Оқушылар материалдарды өз бетінше зерттей алады, білімдерін тексере алады және кері байланыс ала алады, бұл олардың оқуын айтарлықтай жақсартады.

2-сурет. Химиялық ұғымдарды тереңірек үйренуге көмектесетін интерактивті қолданбалар

3. Жобалық тапсырмалар. Химия саласындағы нақты мәселелер мен қиындықтарға негізделген жобалық тапсырмалар енгізілді. Мектепте жасалынған «ECO Болашақ» жобасы арқылы оқушыларды тапсырмаларды шешу, жобаларды әзірлеу және зерттеу нәтижелерін ұсыну үшін STEM технологияларын пайдалана отырып, топтарда жұмыс істеуді дағдыланады, ал бұл өз кезегінде теориялық білімді практикада қолдануға және ұжымда жұмыс істеу дағдыларын дамытуға мүмкіндік береді.

3-сурет. «ЕСО Болашақ» жобасы

Осы практикалық аспектілердің барлығы оқушыларға химияны тереңірек және толық түсінуге, сыни ойлауды дамытуға және алған білімдерін іс жүзінде қолдануға мүмкіндік береді, болашақ ғылыми мансапқа сәтті дайындалудың кілті болып табылады.

Қорытындылай келе, химияны оқытуда STEM технологияларын қолдану бүгінгі таңда оқу процесінің тиімділігін арттырып қана қоймай, оқушылардың дағдыларын дамытуда шешуші рөл атқарады. Виртуалды зертханалар мен интерактивті қосымшалар сияқты инновациялық әдістер оқушыларды қызықтырып, сонымен қатар оқытуды дараландыруға және заманауи ақпараттық қоғамға сәтті бейімделу үшін қажетті дағдыларды дамытуға ықпал етеді. Осылайша, химияны оқытуда STEM технологияларын қолдану ғылым мен технология саласындағы құзыретті және болашаққа дайын мамандарды қалыптастыруға ықпал ететін заманауи білім берудің ажырамас бөлігі болып табылады.

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CHALLENGES OF CHEMISTRY TEACHERS IN SCHOOLS

Abstract. The STEM education system is one of the most important areas in demand for the 21st century. (M. Biasutti and H. El-Deghaidy, 2014) However, the full implementation of Stem education in the field of education is currently causing some difficulties for school teachers, school heads, and administration. In the study of this issue, since chemistry is one of the 4 subjects included in the integrative STEM education system, the main attention was paid to the works of scientists who study the problems encountered in STEM education in general. In the research work, more than 10 articles of

foreign scientists studying the general field of STEM education were reviewed and about 9 problems faced by chemistry teachers in STEM education were identified. The article used the literature review method of research.

Key words: STEM education, Challenges of STEM education, Chemistry teacher

Introduction

Development of various skills of schoolchildren, realizing modern interests, allows training of intelligent and competitive specialists. Concurrent development and systematic learning in core academic areas such as science, mathematics, technology, and engineering are critical to an integrated STEM education. Currently, chemistry as a subject cannot fully realize the actual goals of integrative STEM education. In the course of identifying the problems faced by chemistry teachers in integrative Stem teaching, some scientific literature was studied and analyzed. Nadelson and Seifert (2017) discussed developing interdisciplinary lesson plans, lab experiments, technology-based learning tools, or online platforms for learning materials, while Shernoff, D. J., Sinha, S., (2017) suggested that teachers only have one issue such as educational orientation, training of stem teachers are considered. This theoretical study aims to explore the challenges faced by chemistry teachers in Integrative STEM teaching. Identifying these issues is important because it allows for the improvement of pedagogical practices and contributes to the advanceme nt of STEM education. Additionally, it aims to identify and dissect specific barriers chemistry teachers face when integrating STEM subjects. Based on these given facts, I will study the level and relevance of these issues in Kazakhstan.

Theoretical part

It is true that the full implementation of Stem education in the field of education is currently causing some difficulties for school teachers, school leaders and administration. Since chemistry is one of the 4 subjects included in integrative STEM education, I recommend paying attention to the works of scientists who study the problems encountered in STEM education in general.

Vietnamese scientists Le, L.T.B., Tran, T.T. and Tran, N.H. (2021) described in their article the challenges faced by Vietnamese chemistry teachers in teaching STEM. The study was conducted through interviews and questionnaires with teachers in Vietnam. The results of the study showed that there are 4 different problems. In particular, there is insufficient knowledge of teachers in Integrative Stem teaching, insufficient curriculum and materials, and insufficient time and space, special resources. The same problems in the studies of K. Margot and T. Ketler (2019). K. Margot and T. Ketler studied 25 articles in this direction during the research and classified all the problems encountered into 6 groups. They are pedagogical challenges, curricular challenges, structural challenges, student concerns, assessment concerns, and teacher supports. The following work by J. Shernoff, S. Sinha (2017) addresses the following questions for teachers. The cited article aims to identify challenges and needs in promoting integrated approaches to STEM education. Using a key informant approach, 22 K-12 teachers and four administrators were interviewed as potential leaders in STEM education in an unknown state on the east coast of the US. The research results showed the following new problems in addition to insufficient teacher education: insufficient time for lesson planning, school structure and organization, state testing, assessments for STEM achievement, perceived lack of resources, and teacher education. In addition, the study participants provided specific recommendations for teacher education needed to strengthen integrated STEM education. The next research paper is an article by Buber A. (2023), this study explored

the experiences and perceptions of 20 third year science teachers involved in STEM practices in a Turkish public university. The study addressed three main questions: (1) What are the attitudes of STEM teacher candidates? (2) What benefits and challenges did they experience during their STEM experience? (3) How do they perceive STEM education and its implications for students and teachers? A qualitative case study approach was used to gather insights from the PSST. Content analysis was used to analyze the collected data. As for the results of the research, the most frequently mentioned problems in the research were 32% - Difficulty with time management, 12% - Insufficient materials, 10% - Challenges in classroom management.

Nadelson, L. S., & Seifert, A. L. (2017) address the same issues in their article. In the paper, scholars consider the advantages and disadvantages of integrative and distributed STEM teaching in general. The authors, noting the difficulty of teaching 4 subjects together in Integrative STEM education, put forward critical issues such as creating a curriculum in STEM education, organizing evaluation and teaching, and teachers' knowledge and professional thinking. The work of H. El-Deghaidy and N. Mansour (2015) is the first study to describe the STEM education system in Saudi Arabia. This research work aims to identify the factors that facilitate and hinder STEM education. Teacher reflection and interview protocol were used as research tools. 21 teachers from 21 different schools in Saudi Arabia participated in the study. According to the authors, there is no concrete plan for integrative STEM teaching in Saudi Arabian schools, but all conditions are created in the laboratory for practical teaching of science subjects. And the plan of the work to be done in the laboratory, the curriculum has not been started. Based on these factors, we can consider curriculum and curriculum as a problem.

Summarizing the above information, teachers and education system in STEM education were somewhat discussed in the works of the above-mentioned scientists, and a literature study was conducted. Based on this, the purpose of this research work was to determine the problems of chemistry teachers in STEM education by studying the works of foreign and domestic scientists. Two research questions guided the research: (1)What are the main problems in STEM education? (2) What are the problems of chemistry teachers in integrated STEM teaching?

Methodology

A literature review research method was used to carry out the research. About 20 works of foreign and domestic scientists written on STEM education were studied. These articles were about the Stem education system, the common mistakes made in Stem education, the shortcomings of current Stem education and the problems faced by teachers. Research works of scientists were taken from the Google Scholar platform. Keywords such as STEM education, problems in the STEM education system, and problems of chemistry teachers in STEM education were used to search for the article. The scientific articles were shown in the following table (Table 1). Each challenge or issue was presented with frequency and percentage calculation as analysis method.

Article	Number

Büber, A., 2023; El-Deghaidy, H., & Mansour, N., 2015; Lee, M. H., Chai, C. S., & Hong, H. Y.,2019; Le, L. T. B., Tran, T. T., & Tran, N. H., 2021; Margot, K. C., & Kettler, T.,2019; Nadelson, L. S., & Seifert, A. L., 2017; Oztay, E. S., Aydin Gunbatar, S., & Ekiz Kiran, B., 2022; Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L., 2017; Shidiq, A. S., Permanasari, A., & Hernani. (2020, March); M. Biasutti and H. El-Deghaidy., 2014	10 articles

Table 1. Presentation name of the searched articles

Result

After a comprehensive study of the data, 8 different problems faced by chemistry teachers in STEM teaching were identified. The results of the research work are shown in table 2. The table provides a breakdown of the various issues and research articles in STEM education, along with their frequency and percentage in the literature. Among the identified problems, the most common are Lack of a curriculum framework (60%) and Teachers' knowledge and professional thinking (60%). This result indicates that the main problems in STEM teaching are the lack of curriculum and teachers' knowledge. And the least common problems Insufficient time for lesson planning (10%), Insufficient time for lesson planning (10%) do not require research or do not mean that these problems do not exist.

	Problems	**Article name**	**Frequency**	**Percentage**
1.	Assessment concerns	Le, L. T. B., Tran, T. T., & Tran, N. H. (2021); Margot, K. C., & Kettler, T. (2019).; Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017).	3	30%
2.	Challenges in classroom management, organizing evaluation and teaching	Büber, A. (2023); Nadelson, L. S., & Seifert, A. L. (2017); El-Deghaidy, H., & Mansour, N. (2015).	3	30%
3.	Difficulty with time management	Büber, A. (2023).	1	10%
4.	Inflexible school structure and organization	Le, L. T. B., Tran, T. T., & Tran, N. H. (2021); Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017).	2	20%

	Problems	Article name	Frequency	Percentage
5.	Lack of a curriculum framework	Le, L. T. B., Tran, T. T., & Tran, N. H. (2021); Margot, K. C., & Kettler, T. (2019); Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017); Nadelson, L. S., & Seifert, A. L. (2017); El-Deghaidy, H., & Mansour, N. (2015); Oztay, E. S., Aydin Gunbatar, S., & Ekiz Kiran, B. (2022).	6	60%
6.	Insufficient time for lesson planning	Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017).	1	10%
7.	Teaching materials and resources	Le, L. T. B., Tran, T. T., & Tran, N. H. (2021); Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017).	2	20%
8.	Teachers' knowledge and professional thinking	Margot, K. C., & Kettler, T. (2019); Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017); Nadelson, L. S., & Seifert, A. L. (2017); El-Deghaidy, H., & Mansour, N. (2015); Shidiq, A. S., Permanasari, A., & Hernani. (2020, March); Lee, M. H., Chai, C. S., & Hong, H. Y. (2019).	6	60%
9.	STEM cannot be applied to all chemistry materials	Shidiq, A. S., Permanasari, A., & Hernani. (2020, March).	1	10%

Conclusion

At the end of the study, 10 different articles written in the field of STEM education were studied, and 8 different problems faced by chemistry teachers in STEM education were identified. As the main ones, we can consider such critical issues as Assessment concerns (30%), Challenges in classroom management, organizing evaluation and teaching (30%), Lack of a curriculum framework (60%), Teachers' knowledge and professional thinking (60%). As a solution to these problems, I propose the preparation of model STEM education programs and lesson plans for general education schools and the preparation of special qualification courses that teach STEM education.

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EFFECTIVENESS OF HANDS-ON CHEMISTRY EXPERIMENTS IN HIGH SCHOOL EDUCATION

Abstract. Practical laboratory work is essential to secondary school education, especially when it comes to chemistry and other related disciplines. This study assesses how well-developed skills, piqued scientific curiosity, and improved learning outcomes are all achieved through hands-on chemistry activities. In Kazakhstan, data was gathered from 75 students in the 10th and 11th grades of state general education schools through the use of a mixed-method technique that combined questionnaires and interviews. The majority of students confirmed that laboratory work helps with memorizing, improves enjoyment of chemistry, increases motivation, and improves general attitude towards the topic. The results show that these comments were overwhelmingly positive. Despite these advantages, problems including a lack of resources and equipment keep hindering thorough practical training. Ensuring fair access to high-quality education requires addressing these issues. This study highlights the importance of innovative teaching approaches and adequate resources to promote student engagement and success in science and technology.

Keywords: Hands-on laboratory work, Practical Chemistry, Chemistry

Introduction

Education in every country aims to develop literacy and advance science, marking a country's development. Science courses, particularly chemistry, are beneficial to students and society. Chemistry covers both theory and practice and for this reason, learning labs are designed in such a way that they support and enhance the process of finding and synthesizing ideas and materials (O'Connell, 2013). This means the laboratory must be well-equipped with the necessary equipment for effective learning. This study examines the effectiveness of practical chemistry experiments in secondary schools for skill-building and fostering scientific interest.

There is however a growing debate about the effectiveness and input of laboratory activities in fulfilling today's major purpose of science education, which is not to acquire scientific knowledge but to create it.

Despite this controversy, Schramm (2013) asserts that well-planned laboratory activities facilitate the development of a relevant learning environment intended to achieve this goal. The uniqueness of the laboratory work is demonstrated by the creation of a learning environment that favors both practical and mental activities. To (Osborn and Dillon, 2010), the experience obtained through experimental work provides a lasting impact on the minds of the students. This allows the teacher to inculcate various skills in the scientific process. Science laboratory plays an important role in helping us to change the learning environment where students, working in small groups, improve their understanding of scientific concepts, inquiry skills, and scientific attitude by investigating scientific phenomena (Hofstein & Lunetta, 2003).

Despite the debate surrounding the role of laboratory activities in contemporary science education, well-planned experiments are advocated for creating a conducive learning environment, promoting practical and mental engagement. However, in Kazakhstan, schools face challenges such as equipment shortages and limited resources, hindering comprehensive practical education. Rectifying this requires concerted efforts from educational authorities to ensure adequate resources for laboratory work.

Practical chemistry experiments enhance knowledge and cultivate skills vital for success in science and technology careers, such as data analysis and problem-solving. They catalyze students' interest in science, particularly in a world increasingly reliant on scientific and technological innovations. Improving practical chemistry education in secondary schools enhances education quality and fosters a competitive scientific community capable of addressing contemporary challenges. This paper delves into the efficacy of teaching chemistry through practical work settings.

Literature review

In modern education, the integration of technology into traditional teaching methods has become one of the most important trends, especially in science education.

The effectiveness of virtual laboratories compared to paper-based laboratories in developing practical skills in chemistry has attracted considerable interest. This very issue was addressed in a study by Manyilizu, M. C. (2023). The author discusses research on the effectiveness of virtual laboratory experiences compared to paper-based experiences in improving hands-on chemistry practical skills in Tanzanian secondary schools. It highlights the challenges faced due to the lack of physical laboratory resources and the benefits of virtual laboratories in enhancing student learning outcomes. The study emphasizes the importance of practical sessions in science education, especially in STEM subjects, and suggests that virtual laboratories can complement traditional hands-on labs, offering flexibility, cost-effectiveness, and enhanced learning opportunities for students.

These studies provide valuable insights into the effectiveness of different teaching methodologies, especially in chemistry education, shedding light on the potential benefits and challenges of hands-on experience. For instance, Iyamuremye, A., Nsabayez, E., Ngendabanga, C., & Hagenimana, F. (2023) analyzed the impact of hands-on chemistry activities on students' academic performance, engagement, and experience. For this purpose, a descriptive method and a mixed research design including a chemistry test and a survey with a variety of questions were used.

The findings indicated a high level of student engagement and positive experiences related to practical chemistry classes. The intervention resulted in statistically significant changes in students' academic performance. However, no statistically significant differences were found in the study results based on gender or type of student's school.

The study also identified certain challenges to effective hands-on chemistry classes, including lack of chemical reagents, limited laboratory equipment, limited laboratory space, and insufficient time allocation for hands-on activities. The authors suggest providing additional equipment, utilizing local resources, and increasing laboratory time as possible solutions.

An equally relevant study was also conducted by Adkins, D. G. (2020) in which she investigates the effect of laboratory experiments on students' attitudes and interest in science through various tests and analyses. The results indicate positive outcomes of hands-on activities and potential problems with computer simulations. The study aims to increase understanding of science education and the importance of hands-on experience. The study highlights the importance of hands-on learning in developing positive attitudes and interest in science in students. The study examines the definition of science, scientific hypotheses, and theories, stressing the importance of empirical evidence in scientific inquiry and the development of valid explanations.

Also, Hensen, C., & Barbera, J. (2019) explore the role of hands-on and simulation experiments in improving students' understanding of physical chemistry concepts and demonstrate a significant improvement in student performance when using these methods. The article emphasizes the importance of incorporating these active learning strategies into the teaching of chemistry to promote better student engagement and understanding of the material. The study also highlights the positive impact of peer collaboration and meaningful discussions during experiments, leading to improved learning outcomes in physical chemistry courses. Furthermore, the article highlights the potential of these interactive approaches to develop students' critical thinking skills and deeper conceptual understanding, which ultimately contributes to their success in chemistry.

According to this literature review, our article aims to evaluate the effectiveness of hands-on experiments in high school chemistry, in particular, to investigate their impact on skill development, student interest, and overall learning outcomes.

The main research question is: What is the effectiveness of hands-on chemistry experiments in secondary school to develop skills, increase interest, and improve overall learning outcomes in the subject, especially when dealing with problems such as lack of equipment and limited resources?

Methodology

3.1 Research methods

This research uses a mixed method combining questionnaires and interviews. The survey will be administered to secondary school students of secondary schools in Kazakhstan to assess the current status of practical experiments in chemistry. Survey will be conducted with 10th and 11th-grade

students. The collected data will be analyzed to evaluate the effectiveness of practical chemistry experiments in secondary schools and recommend their improvement.

3.2 Sampling

The study involved 75 students of 10th and 11th grades of state general education schools in Kazakhstan. Using a mixed method combining questionnaires and interviews, the study evaluates the effectiveness of practical experiments in chemistry. The data obtained will serve as a basis for recommendations to improve the effectiveness of these experiments in secondary schools. Ethical standards were followed during the data collection process to ensure the confidentiality and informed consent of the participants.

3.3 Data collection

In research, surveys were conducted to assess the effectiveness of practical chemistry experiments. In addition, individual students were interviewed to gain a deeper understanding of their experiences. The survey questions were about laboratory and practical work in chemistry, and the interviews included the process of learning, and engaging with the subject matter.

3.4 Data analysis

During data acquisition, the data was analyzed to obtain the result. The table below shows the questions and answers of students in percent depending on the response option.

Result

If we analyze the statistics obtained during the survey and interviews, we get the following results:

93,33% answered "yes" to the question - Do you think that laboratory work helps to memorize the material better than theoretical classes only?

82,67% answered "yes" to the question - Do chemical experiments make learning chemistry more fun?

76% answered "yes" to the question - Do chemical experiments influence your motivation to study chemistry and your general attitude towards the subject?

88% answered "yes" to the question - Do chemical experiments influence your memorization and application of theoretical knowledge of the subject?

Questions	Answers 75			
1. How often do you conduct chemical experiments in chemistry class?	Once a week (6,67%) 5	Once a month (16%) 12	Rarely (52%) 39	Almost never (25,33%) 19

2. Do you think that laboratory work helps you to memorize the material better than theoretical study alone?	Yes (93,33%) 70		No (6,67%) 5	
3. What difficulties do you experience when performing chemical experiments at school?	Lack of experience (25,33%) 19	Lack of practical work (34,67%) 26	No basic knowledge (22,67%) 17	I don't find it difficult (17,33%) 13
4. Do you feel that doing chemistry experiments at school helps you to be better prepared for future career opportunities in chemistry?	Yes (70,67%) 53		No (29,33%) 22	
5. How would you rate your overall motivation and interest in learning chemistry after doing the hands-on activities? (From 25 to 100)	25 (9,33%) 7	50 (18,67%) 14	75 (34,67%) 26	100 (37,33%) 28
6. Do you think that doing chemistry experiments helps you better understand the role of chemistry in everyday life?	Yes (49,33%) 37		No (50,67%) 38	
7. Do chemical experiments make learning chemistry more fun?	Yes (82,67%) 62		No (17,33%) 13	
8. Do chemical experiments affect your motivation to learn chemistry and your general	Yes (76%) 57		No (24%)18	

attitude towards the subject?		
9. Does conducting chemical experiments affect your memorization and application of theoretical knowledge of the subject?	Yes (88%) 66	No (12%) 9

According to the obtained data, we can say that laboratory and practical works are interesting and exciting, which increases the involvement in the subject and helps to remember the principles of action and theory of chemistry, and this contributes to good memorization of the material and the program. To all this can also be added an increase in motivation to learn chemistry and a general attitude towards the subject. In parallel with these data, we also learned that most schools do not organize this kind of class for various reasons. The most popular ones are:

- No necessary equipment
- Shortage or lack of chemical reagents
- No provision for laboratory work

During the interviews, we also found that without practical work, the process of learning chemistry is still not very interesting, and teachers are still monotonous in the teaching process, and innovations in teaching are not changing in line with technological advances. And conducting lessons using laboratory work was something new to them and students felt clarity and interest in the subject.

Conclusion

In summary, this study emphasizes the crucial role of practical chemistry experiments in the secondary school learning process. The results confirm that laboratory work significantly enhances learning: the vast majority of students report that it promotes memorization, makes chemistry more interesting, increases motivation, and improves their overall attitude toward the subject. However, despite the obvious benefits, the study has identified serious problems preventing the widespread adoption of hands-on experiments, including lack of equipment and resource constraints. Addressing these obstacles is critical to ensuring equitable access to quality education. In addition, the study highlights the need for innovative teaching approaches to keep pace with technological advances and promote student engagement. By prioritizing hands-on chemistry learning and overcoming existing barriers, teachers can create a dynamic learning environment that fosters scientific curiosity and equips students with the necessary skills to succeed in science and technology.

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ISSUES OF THE INTEGRATIVE STEM LESSON FOR SCHOOL

Abstract. This study was designed to determine the level of STEM integration, particularly in chemistry lessons, and what difficulties/benefits this action may have. The study included 18 articles by different authors on different topics, but with one goal - STEM integration. The result showed that out of 18 articles, 16 partially contain the idea of integrating STEM methodology. In particular, 7 articles were designed to integrate STEM in high school. the rest were intended for teachers in general. None of the articles were intended for elementary school.

Keywords: STEM education, integrated STEM in school

Introduction

In modern education, there is a gap between traditional teaching methods and the needs of modern society. As the study shows, many schools and educational institutions still adhere to the lecture approach, ignoring the principles of active and practical learning. (Felder, R. M., & Brent, R. 2024). However, in a dynamically changing world, where the skills of applying knowledge in practice and solving real problems are in demand, standard teaching methods become ineffective. In this context, stem education plays a key role, combining science, technology, engineering and mathematics into a whole educational process. This research is aimed at developing software for teaching the basics to school,

taking into account that it can contribute to the development of critical thinking, new methods of problem research and creativity. The basis of this approach is the constructivist philosophy of learning, which emphasizes the importance of active interaction of students with educational material. In addition, in the context of modern educational requirements, special attention is paid to the integration of technologies that not only facilitate the learning process, but also develop digital literacy, which is necessary in the modern information society.

Literature review

Implementation of stem in school play vital role in creating advanced education at all. And to reach this goal for example I took an article of Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021). This work was carried out to research integrated STEM curricula. It created conceptual flow charts (CFGs) for 50 such programs to categorize and understand the nature of curriculum integration and coherence. The study identified four main types of integrated STEM programs: scientifically coherent units with a vaguely related engineering assignment (EDC), units focused on engineering design with limited connections to scientific content, units where engineering design is used as a context for scientific content, and fully integrated and coherent STEM units. The findings indicate that engineering practices can serve as a contextual integrator within the STEM curriculum, and the use of EDC provides the potential for conceptual integration, since engineering is based on the application of science and mathematics.

Also, in opinion of Jamal, S. N., Ibrahim, N. H., Surif, J., Suhairom, N., Abdullah, A. H., & Jumaat, N. F. (2017) make a study about understanding STEM in Chemistry in their region and their study was conducted among 20 chemistry teachers in order to identify their understanding of STEM education and develop a teaching strategy in accordance with this understanding. The study was conducted in eleven schools in Malacca County and used the Tengah approach and qualitative research methodology. Open-ended questions were used to collect data, which were analyzed using thematic analysis. The results showed that most teachers defined STEM education as the integration of science, technology, engineering and mathematics. However, some of them did not feel confident in understanding or implementing STEM education into their practice. This study aims to highlight the importance of STEM education in modern education and help teachers and students better understand and implement it in the learning process.

According to methods of introducing STEM chemistry in school Fitriyana, N., Wiyarsi, A., Pratomo, H., & Marfuatun, M. (2024) make research in Indonesia and they notice that The various goals facing secondary schools and vocational schools in Indonesia play an important role in shaping the preparedness of chemistry teachers to use the STEM approach in their work. Despite this, both high school chemistry teachers (HSCT) and chemistry teachers in vocational schools (VSCT) should be positive about STEM, as it offers students a more meaningful study of chemistry. This study examined the views of chemistry teachers on the potential of STEM learning in their classrooms. 131 chemistry teachers from Indonesia participated, the study was conducted using a saturated sample method. The STEM Perception Scale (PC-STEM) was used to collect the data. The results showed that both HSCT and VSCT are positive about STEM. This means that integrated STEM learning can be successfully used in chemistry lessons in both categories of educational institutions. However, no statistically significant differences were found in the views of HSCT and VSCT on the use of STEM in chemistry teaching. Despite the positive attitude, both groups of teachers noted a lack of experience in using STEM in

chemistry lessons. Thus, in order to successfully integrate STEM-based chemistry education, chemistry teachers need a special STEM professional development program.

If we will look at the idea of integration STEM, there will be some problem Aydin-Gunbatar, S., Tarkin-Celikkiran, A., Kutucu, E. S., & Ekiz-Kiran, B. (2018) researched the impact of a 12-week design-based STEM course on pre-service chemistry teachers' content knowledge, STEM conceptions, and engineering perspectives. Through five STEM activities addressing real-life problems and an iterative engineering design process, eight junior pre-service teachers participated voluntarily. Data analysis revealed a significant deepening of content knowledge and a shift in perceptions towards integrated STEM education and engineering design. Implications for integrating STEM courses into pre-service teacher education programs were discussed.

The purpose of the study to investigate the key issues of Integrated STEM in secondary schools according to the various literature. The research question is “what kinds of issues were discussed in literature”.

Methodology

And Also, while searching information for this article I use google scholar platform, especially I was looking for those articles that conducted to key word “integrate STEM education” and all articles that I found I read and then make a result table. In the course of my research work, I studied the works of other authors, comparing them with the topic of integrating STEM into education, in particular, into teaching chemistry. To show a more accurate result in this article, I used 18 articles taken from the Google Scholar platform. After a long and thorough analysis of the articles, I found that 16 of them fully meet the objectives of the study, offering valuable information on the practical application and effectiveness of project-based learning as part of the implementation of the modular plan for an integrative STEM lesson in school.

Result

Article №	Key issue	Author, main idea	№ of articles	Percentage of key issue
1	STEM education	Felder, R. M., & Brent, R. 2024	8	44,72%
2		Kubat, U. (2018).		
3		Jamal, S. N., Ibrahim, N. H., Surif, J., Suhairom, N., Abdullah, A. H., & Jumaat, N. F. (2017).		
4		Ananda, L. R., Rahmawati, Y., & Khairi, F. (2023).		
5		Hasanah, S. S., Riandi, A. P., & Kaniawati, I. (2022).		
6		Altan, E. B., & Ercan, S. (2016).		

7		Farwati, R., Metafisika, K., Sari, I., Sitinjak, D. S., Solikha, D. F., & Solfarina, S. (2021).		
8		El-Deghaidy & Mansour (2015).		
9	Integrated STEM	Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021).	5	27,78%
10		Fitriyana, N., Wiyarsi, A., Pratomo, H., & Marfuatun, M. (2024).		
11		Du, W., Liu, D., Johnson, C.C., Sondergeld, T.A., Bolshakova, V.L.J., & Moore, T.J. (2019).		
12		Honey, M., Pearson, G., & Schweingruber, H. (2014).		
13		Bryan, L.A., Moore, T.J., Johnson, C.C., & Roehrig, G.H. (2015).		
14	Professional development in STEM Education	Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012).	1	5,5%
15	STEM courses	Aydin-Gunbatar, S., Tarkin-Celikkiran, A., Kutucu, E.S., & Ekiz-Kiran, B. (2018).	1	5,5%
16	STEM effectiveness	Fatayah, F., Yuliana, I. F., & Priyasmika, R. (2022).	1	5,5%
17	pedagogical content knowledg	Kulgemeyer, C., & Riese, J. (2018).	1	5,5%
18	STEM inquiry-based learning	Abdurrahman, A., Nurulsari, N., Maulina, H., & Ariyani, F. (2019).	1	5,5%
Total			18	100%

In this table, I have given examples of the studied works and reduced the percentage of their binding to a specific keyword. As we can see, there are more than 44% of articles on STEM education, which indicates that generalized information about STEM is very popular and perhaps easy to research and explain. On the contrary, there were fewer works on the question of integrating the STEM methodology

by 16.94% less, and this leads to the idea that explaining the integration of the methodology is more complex and difficult for research. As for other articles, we can see that their main idea is probably not popular, since there were not so many such articles. Based on these figures, it can be assumed that in the future these topics need to be explored much more, since it is possible that they contain answers to the questions that we still cannot answer

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STEM – БАСТАУЫШ СЫНЫПТА БІЛІМ БЕРУДІ САПАЛЫ ҰЙЫМДАСТЫРУДЫҢ НЕГІЗГІ ҚҰРАЛЫ

Аңдатпа. Бүгінгі таңдағы алуан түрлі цифрлық білім ресурстары кіші жастағы балаларға мүмкіндік бере отырып, оқушыларға әр түрлі құбылыстарды оқып зерттеуге, модельдер құруға және тәжірибеден өткізуге, өз күші мен ұмтылыстарымен өзінің интеллектуалдық әлемін көрсетуге көмектеседі.
Осыған байланысты қазіргі заманғы жалпы білім беретін мектептерде мақсатқа бағытталған ғылыми-зерттеу жұмыстары оқушылардың әртүрлі өмірлік жағдайларда қолдануға болатын тәжірибелік дағдыларды дамытатын тәсілдерінің бірі болып табылады.

Түйінді сөздер: STEM, технология, роботтехника, конструктор.

STEM технологиясы білім алушылардың белсенділігін арттыруға мүмкін беретін оқу ортасын құру. Кез келген жағдайдың шешуін анықтап, тауып, өзара пікірлесе отыра қорытынды жасайды. Осы тұста белсенділіктері артып, кез келген ақпаратты, тұжырымды, ережені жақсырақ естерінде сақтап қалады. Себебі, STEM технологиясы оқушыларды сыни ойлауға, креативті ойлауға, өз бетінше білім алуға жетелейді. Мұғалім кез келген технологияны, әдіс тәсілді пайдаланғанда оқушылар үшін тиімдісін іздейді. Оқушы жаратылыстану, дүниетану, математика т. б сабақтар бойынша білімдерін толықтырып, түрлі ақпараттармен танысып жұмыс жасайды. Бірақ кейбір жағдайларда оқушылар үшін анықтамаларды, түсіндірмелерді бірден түсіну қиынға соғады. Ал, кейбір оқушыларға кез келген ақпарат түсінікті болады, өз шамасына қарай түсінеді.

Алған білімдерін қалай? қайда қолданамын? деп қызығушылықтары артып жатады. Сондықтан оқушының бастапқы білімі мен жаңа білімді ұштастыру маңызды сонымен қатар, кез келген жерде, өмірде қолдану үшін практикалық тұрғыда көптеген қызықты тәжірибелік жұмыстарды тапсырмаларды жоспарлап ұйымдастыра білуіміз қажет. Оқушы алған теориялық білімін, ережені есінде ұзақ уақыт сақтауы үщін тәжірибелік жұмыстар арқылы жаңа білімді меңгертіп алуымыз қажет. STEM ерекшелігі – бұл пәнаралық байланыс принципі, яғни бірнеше пәнді біріктіре отырып, бірнеше пәндерден алған білімді қоса отырып, жаңа бір қолданбалы зат жасап шығарады.


Өз іс-тәжірибемізге тоқталатын болсақ, ана тілі пәнінен «Нан қайдан шығады?» атты STEM технологиясы арқылы меңгертуге болады. Жұмыс барысында, біріншіден, ғаламтор желісінен ертегімен таныстық. Екіншіден, нанның әзірленуі бидайдан бастау алатындықтан, оқушылармен бидай масағын зерттедік, кейін сыныптағы кішкентай арулар ұннан қамыр иледі. Соңғы қадам бауырсақ пісіру болды, бұл жолы мектеп асханасындағы аспазшы мамандар көмектесті. Міне, осы жүйеленген іс-әрекеттер арқылы «Ас атасы нанның» дастарқан басына қалай келетінін білді.

Дүниетану сабағында «Су. Судың күйі» тақырыбын өту барысында, алғашқы және дәстүрлі іс-әрекетіміз оқулықтағы мәтінмен танысу.

Теориялық білімді практикамен ұштастыру мақсатымен және судың жақсы еріткіш екендігіне көз жеткізу үшін эксперимент жасадық. Суға қант салып араластырамыз. Қант еріп кетеді. Суға бір қасық тұз салып араластырамыз. Тұз суда ериді. Эксперимент нәтижесінде оқушылар судың қандай күйде болатынын бақылап, талдап, салыстыра отырып, қорытынды шығара білуге үйренді. Су адам еңбегінің көмекшісі, оны әр салада және күнделікті өмірде қолданады (мысаллы: егістікте, зауытта, фабрикада). Алған білімдерін бекіту мақсатында, «Бес жолды өлең» құрастыру арқылы оқушылардың сөздік корын молайту.


STEM технологиясы арқау болған тағы бір зерттеу жұмысымызды ұсынамыз. Біз табиғаты көркем, таулы бөктері, әдемі көркем саябақтары бар Алматы қаласында тұрамыз. Күзгі ағаштарды тамашалауға саябаққа оқушылармен топ серуенге шықтық. Әр ағаштың түбінде жатқан пластик шөлмектеріне көзіміз түсті. Пластик шөлмектер жерді ластап, табиғатқа зиянын тигізеді. Бұл шөлмектерді лақтыруға болмайтынын анықтап, шірімейтіндігін зерттедік, ал өртеген сәтте адам денсаулығына зиянды улы түтін бөлетінін анықтадық. Пластик шөлмектерді екінші өмір беріп, үй тұрмысына пайдалы, сәнді заттар жасауға болатынынына көзіміз жеткеннен кейін, бұл тақырып айналасында зерттеу жұмысын бастап кеттік. Зерттеу жұмысымыздың тақырыбы: «Қалдықтарды табысқа айналдырайық». Зерттеу жұмысы басталғаннан кейін, оқушылар пластикалық шөлмектерді жинап, олардан басқа пайдалы заттар жасай бастады. Шөлмектердің қолданылған қалпын өңдеп, эстетикалық тұрғыдан әсемдеді. Мысалы: қалам салатын қорап, шыршаны сәндейтін ойыншықтар, гүл салатын құмыралар, жинақ сандықшалар және т.б көптеген заттар жасап шығарды. Нәтижесінде, оқушылар ескі заттарға жаңа өмір беруді үйреніп, қолдан бұйымдар жасап, шығармашылық тұрғыдан дамыды.

Мектепте «Робототехника» үйірмесі жұмыс жасайды. Сынып оқушылары бұл үйірмеге белсене қатысады. Робот жасау техникасы және технологиясы оқушылардың қызығушылығын арттырады, себебі балалар топтасып жұмыс жасайды, сыни ойлауға дағдыланады. Робот техникасы туралы «Интернет» желісінен ақпарат іздейді. Алынған ақпаратпен топта жұмыс жасайды. Кішкентай конструктор, кішкентай гидровликалық кран болсын, не жасаса да химия, физика, математика, геометрия пәндерімен жұмыстарын байланыстырады.

Міне, STEM технологиясымен жұмыс жасау, оны өмірде қолдана алу бала үшін өте маңызды. Бала өзінің жасаған бұйымын, өнімін көру арқылы мотивациясы артады.

Осылайша, STEM арқылы білім беру оқушыларды алған ақпаратын қоршаған орта процестерімен байланыстыруға және жобалық ойлануына мүмкіндік береді.

STEM технологиясымен оқыту келесідей дағдыларды дамытады.

- Мотивация алады;
- Білуге деген қызығушылығы артады, оның маңызын түсінеді;
- Сабаққа деген қызығушылығы артады;
- Жоба жасай алады;
- Идея ойлап табады алады;
- Жан жақты дамиды;
- Дарынды оқушылар анықталады;
- Бәсекеге қабілетті болады;
- Сын тұрғысынан ойлай алады;
- Шығармышылық тұрғыдан ашылады.

Қорыта келгенде, STEM технологиясы арқылы жұмыс жасау мұғалім үшін де, білім алушы үшін де қызықты, әрі қажет болып келеді. Оқушылар алған білімдерін практикалық жұмыстар арқылы бекітіп отырса, өз бетінше білім алуға құштарлықтары арта түседі, оқушылардың функционалдық сауаттылықтары қалыптасып, олардың өмірлік және кәсіби перспективалары, өз күштеріне деген сенімділігі артады.

Пайдаланған әдебиеттер тізімі

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THE EFFECTIVENESS OF MODERN METHODS IN TEACHING THE PERIODIC TABLE OF CHEMICAL ELEMENTS

Abstract. This systematic literature review focuses on the exploration of innovative teaching approaches for the study of the periodic table of chemical elements. Given the evolving nature of education, this review examines recent methods that go beyond traditional memorization techniques. The review compiles research from various sources and identifies emerging trends, such as the use of gamification, virtual reality, card games, online platforms, 3D printing, and robotics in teaching the periodic table concepts. By providing educators with valuable insights into effective teaching strategies, this comprehensive review aims to enhance students' understanding and engagement with the concepts of the periodic table through innovative approaches.

Keywords: Periodic Table of Chemical Elements, Modern Teaching Methods, Technological Tools

Introduction

The periodic table of chemical elements has a significant role in the teaching of chemistry. Without this table, it is difficult to conceive of a chemistry lesson. Students learn chemistry by visually representing the principles of the chemical realm. However, it is worth pointing out that the modern version of the periodic table differs significantly from that of ten years ago. The Charles Janet’s version of the periodic table is widely used, which preserves the concept of Dmitri Mendeleev's work. This version differs from the original in that it is longer and more difficult to fit into textbooks due to its length. There is also a more modernized version that has been shortened to fit into books more easily. However, the actual length or shape of the table is not as important as the method used to teach it. For this reason, teaching the periodic table through different methods becomes more significant. For example, Martí-Centelles, et.l (2014) states that the use of a specific program featuring a card game during a chemistry class encourages students to learn well, making the class both interactive and significant. This approach produces positive pedagogic outcomes for students. According to Mintzes, et al. (2006), the periodic table of chemical elements is referred to as "the principal graphical tool in chemistry." This has also been stated by other researchers and scholars, that the Periodic Table of Chemical Elements is an essential component of chemistry education. For example, according to a study conducted by Mhlongo and Sedumedi in 2023, a student who is more proficient in the Periodic Table will better comprehend chemical concepts than one who has struggled to understand it. In this paper, we aim to analyze works that illustrate modern approaches to constructing the periodic table. The

significance of this endeavor lies in comprehending the methods employed by the authors, as well as identifying the purpose behind their work.

Literature review

The article "ChemMend: A Card Game to Introduce and Explore the Periodic Table while Engaging Student Interest" by Vicente Martí-Centelles and Jeniffer Rubio-Magnieño (2014) presents a novel approach to teaching chemistry using the periodic table through a card game. The authors highlight the significance of involving students in the learning process of chemistry, particularly the periodic table, which can often be seen as a challenging and complex subject. They begin by discussing the challenges associated with teaching chemistry, such as the significant amount of information that students must remember and comprehend. The authors contend that traditional teaching methods such as lectures and textbooks may not effectively engage students or foster a deep understanding of chemistry. To address these difficulties, Martí-Centells and Rubio-Magnieño have developed ChemMend, a card game designed to help students learn about the periodic table in a fun and interactive manner. The game matches elements based on their properties, such as atomic number, symbol, and electron configuration. This allows students to reinforce their knowledge of the periodic table and develop critical thinking skills. The authors have provided a comprehensive description of the game mechanics, including instructions on how to set it up and play examples. They have also highlighted the advantages of using a card game for learning, such as promoting collaboration among students and encouraging active participation in the learning process.

The article "Students' Procedure When Solving Problem Tasks Based on the Periodic Table: An Eye-Tracking Study" by Tóthová, M., Rusek, M., and Chytry (2021) investigates high school students' approach to the periodic table when solving problems. Using eye tracking and think-aloud methods, the researchers observed eight students' thought processes as they completed tasks. The aim of the study was to understand the strategies students used and any difficulties they faced. Data collected from eye trackers was quantitatively analyzed to determine the time spent in specific areas, while think-aloud recordings provided additional insights into students' problem-solving strategies. The incorporation of the periodic table into science education is fundamental at all academic levels, as it provides crucial insights into the physical and chemical characteristics of the elements that compose matter. Nevertheless, mastering the intricacies of the periodic table, including element names, symbols, and various properties, can at times be perceived as tedious and uninteresting, depending on the approach educators take to teaching. One way to enhance students' interest is through the incorporation of gamification, which integrates learning seamlessly into gaming, thus creating an immersive and engaging learning experience. The key to this approach is the careful design and development of games that successfully combine entertainment with educational content. In this article, Montejo Bernardo and Fernández González (2021) present "Chemical Battleship," a variation of the traditional board game "Battleship," which is designed to assist in learning about key concepts on the periodic table and introduce students to common laboratory glassware.

The article "Game-based learning approach on students' motivation and understanding of chemistry concepts", written by E. Byusa, E. Kampire, and A.R. Mwesigye in 2022, explores the use of educational games in teaching chemistry and their classification in the context of secondary education. The study focuses on Spanish students aged 15-16 and includes twenty-four one-hour sessions. The research aims to investigate the impact of incorporating game-based learning into a teaching module, with the goal of improving students' understanding of the subject and their perception of games as an

effective learning tool. Data collection includes pre-and post-module assessments as well as a survey on students' learning experiences. Qualitative insights are also gathered through teacher journals. The findings indicate significant improvements among students in their understanding of the structure, nature, and historical background of the Periodic Table. However, there was a relatively lower level of progress in applying acquired knowledge and deducing conclusions based on evidence. Nevertheless, the teaching module successfully addressed the learning challenges associated with this topic. Notably, students who participated in a game-based learning module performed better than those in a control group following a traditional curriculum. Feedback from students regarding the incorporation of games into the instructional approach was overwhelmingly positive, emphasizing the perceived benefits of games in enhancing engagement and active participation in the learning environment. In addition, this study introduces a new educational approach called Task Involving Play (TIP). TIP acts as a bridge between play and more structured learning activities, allowing students to create their own content and take an active role in the learning process. TIP activities are designed to enhance learning through game-based approaches, with a lower level of complexity, greater utility, and increased appeal compared to traditional educational games.

The article "The Role of Robotics and Innovative Teaching Approaches in Chemistry Education: A Case Study of the Periodic Table" by Thabo Mhlongo and Thomas Dipogiso Sedumedi (2024), discusses the potential advantages of incorporating robotic technology and innovative teaching strategies into the teaching of chemistry. The authors emphasize the significance of the periodic table in facilitating the understanding of chemical concepts and the arrangement of chemical elements, and highlight the need for more engaging and effective pedagogical approaches to enhance student learning. This approach encourages student engagement and active learning, enabling them to investigate key concepts through practical pexperiments. With regard to methodology, the paper proposes a multi-disciplinary approach that integrates robotic technology with concept-driven teaching methods. Through the incorporation of practical activities, interactive demonstrations, and collaborative learning opportunities, educators can create an engaging and stimulating learning environment that promotes a deeper understanding of the significance of the periodic table in chemistry education. Furthermore, it promotes the development of critical thinking and problem-solving abilities, which are crucial for success in future fields related to chemistry. According to this literature review purpose of the article to explore effectiveness of modern methods in teaching the Periodic Table of chemical elements. Our research question is: What are the specific methods, chronological order, and educational level of the article under exploration?

Methodology

3.1 Research methods

Data to achieve the research objectives has already been collected using the systematic review methodology. This was done by conducting a literature review to collect published works on modern approaches to teaching the periodic table of chemical elements. The Google Scholar search engine was used with the keyword "Modern Teaching Approaches, Methods" in the search query.

3.2 Sampling

In order to achieve our goal, we reviewed 52 research papers, which included scientific journals, articles, and methodological books. Out of these papers, 23 were selected for further review, and a systematic literature review was conducted based on these papers.

3.3 Data collection

All the articles collected on the topic of modern approaches to teaching the periodic table of chemical elements were analyzed. Various methods were considered, including the use of game cards, an interactive online version of the periodic table, and 3D printing. The potential of artificial intelligence was also explored in teaching periodic table.

3.4 Data analysis

According to the research, two studies were conducted. The first study focused on the use of contemporary methods in teaching the periodic table of chemical elements. This study divided the methods into 10 categories. Additionally, a study was conducted to assess the level of education of the students involved.

Result

According to the data obtained from methodologies based on the results of data analysis, scientific articles have been categorized into ten groups. Each group contains information on a specific teaching approach for the periodic table. Game-based instruction is often included in these categories, as it encompasses various types of games and activities.

Some examples of the methods included in this category are: card games, board games, practical exercises, gaming training, integration of digital native speakers, robotic integration, 3D printing, dance techniques, an online periodic table, and virtual reality. The educational system is divided into the following four levels: elementary school, secondary school, high school, and college or university.

Methods

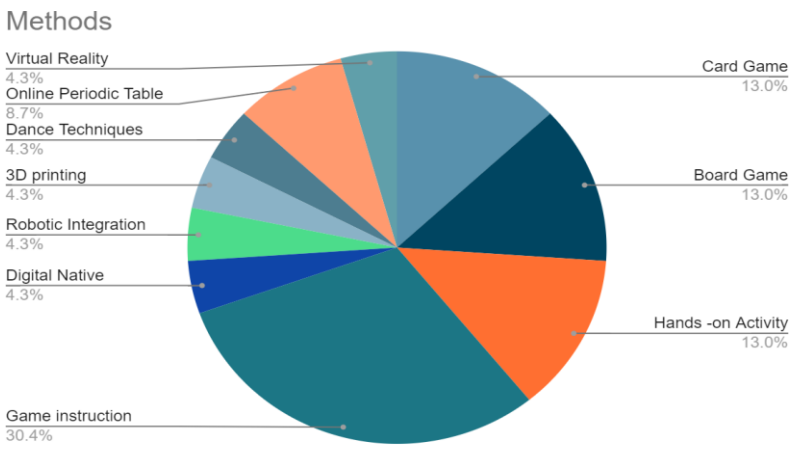
METHOD TYPE	FREQUENCY	CHRONOLOGICAL ORDER	METHOD TYPE	FREQUENCY	CHRONOLOGICAL ORDER
Game Instruction	7	Hassan, N., & Shafiq, M. (2022) Setu, S. A., & Basar, N. (2019) Nsabayezu, E., Iyamuremye, A., Nungu, L., Mukiza, J., Mukama, E., & Niyonzima, F. N. (2023) Trudel, L., & Métioui, A. (2015) Anuar, N. S. A., Fauzi, M. S. M., Azmi, N. H., Ibrahim, N., Saari, E. M., & Razali, F. M. (2021) Joseph, V. C., & Salleh, W. M. N. H. W. (2023) Kara, F. (2019)	Card Game	3	Sukriani, E. (2018) Mahardhika, S., Santoso, F., & Alfath, N. (2017) Piyawattanaviroj, P., Maleesut, T., & Yasri, P. (2019, July)
			Board Game	3	Montejo Bernardo, J. M., & Fernández González, A. (2021) Alejandria, L. N., Bajenting, J. M. S., Pacatan, M. A. L. D., & Tomas Jr, A. D. (2023) Stanley Lourdes Benedict, T. A. P. (2023)
METHOD TYPE	FREQUENCY	CHRONOLOGICAL ORDER	METHOD TYPE	FREQUENCY	CHRONOLOGICAL ORDER
Hands -on Activity	3	Guerra, G. F., Felicio, C. M., Ferreira, J. C., & Noll, M. (2019) Bergman, D. (2020) Pasarudin, N. (2011)	Digital Native	1	Toh, L. M., Gan, B. Y., Pua, J. C. F., & Amin, S. B. M. (2011)
			3D printing	1	Zhang, T., Cummings, M., & Dulay, M. T. (2022)
Online Periodic Table	2	Nsabayezu, E., Iyamuremye, A., Nungu, L., Mukiza, J., Mukama, E., & Niyonzima, F. N. (2023) Pradila, A., & Azra, F. (2022)	Dance Techniques	1	Chong, Y. Y., Cyril, N., & Ng, K. T.
			Virtual Reality	1	Baptista, A., Azevedo, J., da Mota, J. M., Alípio, L., & Maia, G. (2019)
Robotic Integration	1	MHLONGO, T. (2024)			

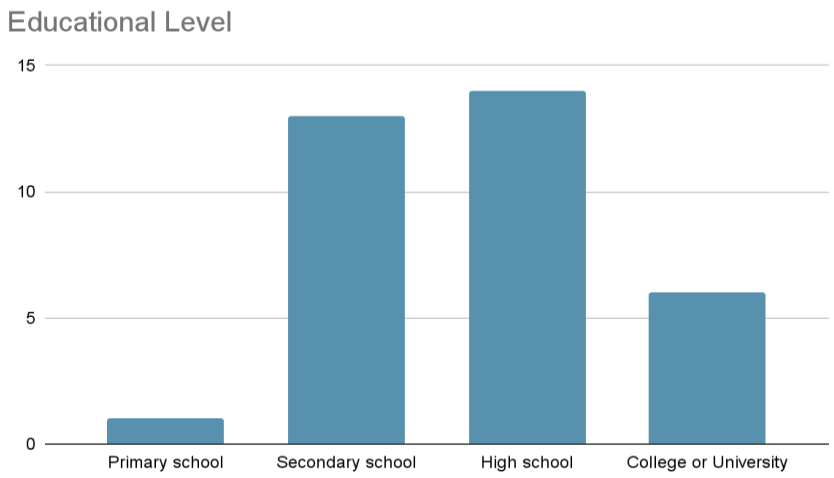
Educational Level

PRIMARY SCHOOL 2	SECONDARY SCHOOL 13	HIGH SCHOOL 14	COLLEGE OR UNIVERSITY 6
Montejo Bernardo, J. M., & Fernández González, A. (2021) Kara, F. (2019)	Nsabayezu, E., Iyamuremye, A., Nungu, L., Mukiza, J., Mukama, E., & Niyonzima, F. N. (2023) Setu, S. A., & Basar, N. (2019) MHLONGO, T. (2024) Anuar, N. S. A., Fauzi, M. S. M., Azmi, N. H., Ibrahim, N., Saari, E. M., & Razali, F. M. (2021) Anuar, N. S. A., Fauzi, M. S. M., Azmi, N. H., Ibrahim, N., Saari, E. M., & Razali, F. M. (2021) Baptista, A., Azevedo, J., da Mota, J. M., Alípio, L., & Maia, G. (2019)	Montejo Bernardo, J. M., & Fernández González, A. (2021) Hassan, N., & Shafiq, M. (2022) Nsabayezu, E., Iyamuremye, A., Nungu, L., Mukiza, J., Mukama, E., & Niyonzima, F. N. (2023) Guerra, G. F., Felicio, C. M., Ferreira, J. C., & Noll, M. (2019) Alejandria, L. N., Bajenting, J. M. S., Pacatan, M. A. L. D., & Tomas Jr, A. D. (2023) Toh, L. M., Gan, B. Y., Pua, J. C. F., & Amin, S. B. M. (2011) Toh, L. M., Gan, B. Y., Pua, J. C. F., & Amin, S. B. M. (2011)	Setu, S. A., & Basar, N. (2019) Toh, L. M., Gan, B. Y., Pua, J. C. F., & Amin, S. B. M. (2011) Joseph, V. C., & Salleh, W. M. N. H. W. (2023) Sukriani, E. (2018) Kara, F. (2019) Stanley Lourdes Benedict, T. A. P. (2023)

PRIMARY SCHOOL 2	SECONDARY SCHOOL 13	HIGH SCHOOL 14	COLLEGE OR UNIVERSITY 6
	PIYAWATTANAVIROJ, P., MALEESUT, T., & YASRI, P. (2019, JULY) KARA, F. (2019) ZHANG, T., CUMMINGS, M., & DULAY, M. T. (2022) PRADILA, A., & AZRA, F. (2022) PASARUDIN, N. (2011) MAHARDHIKA, S., SANTOSO, F., & ALFATH, N. (2017) CHONG, Y. Y., CYRIL, N., & NG, K. T. BERGMAN, D. (2020)	TOH, L. M., GAN, B. Y., PUA, J. C. F., & AMIN, S. B. M. (2011) TRUDEL, L., & MÉTIOUI, A. (2015) PIYAWATTANAVIROJ, P., MALEESUT, T., & YASRI, P. (2019, JULY) STANLEY LOURDES BENEDICT, T. A. P. (2023) PRADILA, A., & AZRA, F. (2022) MAHARDHIKA, S., SANTOSO, F., & ALFATH, N. (2017) CHONG, Y. Y., CYRIL, N., & NG, K. T. BERGMAN, D. (2020)	

Based on the findings from a comprehensive analysis of the data, it has been determined that most current approaches to teaching the periodic table (30.4%) incorporate various types of game-based instruction. Furthermore, the majority of research has focused on Card Game, Board Game and Hands -on Activities (13%). These methods are the most researched. In the second study, educational levels were found to exceed ten and included secondary and high school. This result was expected, as the periodic table is typically taught in schools beginning in secondary education, in accordance with the standards.





Conclusion

In conclusion, the periodic table is a subject that is studied both in other countries and in Kazakhstan, beginning in secondary school. At this time, teachers should focus on finding an effective method for teaching the periodic table. There are numerous options available, including using flashcards with element symbols during lessons, playing games on the board, or other techniques that teachers can devise in collaboration with students using available materials. We also recommend using an online version of the periodic table alongside a paper copy to encourage its use. Authors have employed robotics, virtual reality, and the creation of their own applications in their research. The periodic table of chemical elements forms the foundation of chemical education, making it essential to examine every aspect of how to teach the table effectively in modern times.

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CHALLENGES OF CHEMISTRY TEACHERS IN SCHOOLS

Abstract. This study explores the application of artificial intelligence (AI) in chemistry education through an extensive review of ten academic articles. AI's integration into chemistry education has led to the development of various educational tools, such as personalized learning platforms and virtual labs. These advancements have greatly contributed to enhancing student learning and teacher experiences. The primary activities facilitated by AI include creating and solving open-ended and multiple-choice questions, and answering questions and solving problems. However, the utilization of AI for laboratory work and making scientific predictions remains less common, suggesting these areas are more appealing to college and university students. Recommendations for future research include developing a comprehensive chemistry database to accurately answer complex questions, creating an all-inclusive AI chemistry application, and devising methods to calculate chemical problems using mathematical formulas. This would involve integrating these methods into AI to generate tasks with different formulas and calculations but identical final meanings. Implementing these suggestions could significantly improve students' chemistry skills and promote academic integrity. This study underlines the transformative potential of AI in education, particularly in the domain of chemistry, offering new avenues for enhancing learning outcomes and teaching efficiency.

Key words: Artificial intelligence, Chemistry education, AI in chemistry education

Introduction

As Stephen Haking say, "Success in creating AI would be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks."

Due to the infinity of the human thinking system, new innovative and technological changes are happening and developing in every century. One such technological innovation is artificial intelligence.

Artificial intelligence(AI) is an intelligent machine or software technology that can think at a human level thanks to a large database. Artificial intelligence (AI) is the basis of many service sectors that have adopted new information technologies (S. J. Russell, P. Norvig, 2016). People can use AI for different sides, like finding the answers of unclear questions; help to write assignments; editing the photos by writing details. Although the roots of artificial intelligence date back several decades, there is now a clear consensus that intelligent machines with learning, reasoning and adaptive capabilities are particularly important (Arrieta, A. B., Díaz-Rodríguez,2020). It is thanks to these features that AI methods are achieving unprecedented levels of performance when learning to solve increasingly complex computational tasks, which makes them crucial for the future development of human society (D. M. West, 2018). Recently, the complexity of AI-powered systems has grown so much that they do not require human intervention to design and deploy. When decisions from such systems ultimately affect people's lives, such as medicine, law or defense, there is a need to understand how such decisions can be supported by AI techniques.

Artificial intelligence (AI) is a field of research that combines applications of machine learning, algorithmic generation, and natural language processing Artificial intelligence applications are changing educational tools. AI has various educational applications such as personalized learning platforms that promote student learning, developed virtual labs, and bots that help with homework and projects. Although artificial intelligence has many benefits and advantages in improving student knowledge and teacher experience, it has not been properly applied at the ethical level (Akgun, S., & Greenhow, C., 2022).

Theoretical part

In the age of advanced science and technology, students and teachers are using artificial intelligence positively in the field of education and benefiting from it. As a chemistry teacher, I researched articles on the use of artificial intelligence in chemistry education.

Russian scientists Vladimir L. Kodkin, Ekaterina V. Artemeva (2024) described the progress and uses of neural networks, especially ChatGPT, in different areas like chemistry education and research in the article “ChatGPT: Application in Chemistry Education and Challenges”. It explains the advantages of artificial intelligence and ChatGPT, like their ability to handle large amounts of data, make personalized learning systems, and give suggestions for solving problems. It shows real-life examples of how ChatGPT can help improve learning in chemistry, like making tests, generating multiple-choice questions, studying chemistry topics, and writing scientific ideas in chemistry. It ends by discussing the exciting possibilities of AI to solve complex problems that might be beyond human abilities, opening doors for more research and collaboration between humans and intelligent machines.

From Ohio State University, scientist Ted M. Clark (2023) studied how well an artificial intelligence chatbot called ChatGPT could answer chemistry exam questions in “Investigating the Use of an Artificial Intelligence Chatbot with General Chemistry Exam Questions” article. They tested ChatGPT on exams from two chemistry classes. ChatGPT did a good job at understanding the main ideas in questions that had multiple-choice answers, even when there were lots of chemical symbols. However, it only got 44% of the answers right, which was lower than what most students got. When it came to questions where students had to write out their answers, ChatGPT was good at understanding language, especially for questions that needed general knowledge. But it had trouble with questions that needed specific skills, especially if those skills were taught in lectures. Even though some of its wrong answers

sounded convincing, ChatGPT isn't yet good at giving reliable answers or explanations for many exam questions. However, it could be useful for making assignments where students work on improving ChatGPT's answers.

Researchers Margarida Figueiredo and M. Lurdes Esteves (2014) from Portugal looked into how lab classes in Chemistry learning are taught using artificial intelligence in “Lab Classes in Chemistry Learning an Artificial Intelligence View” article. They studied 702 students in 10th grade in Portuguese Secondary Schools. They used a method called k-Means clustering to group the data into different segments. Also used decision trees to create models explaining the segmentation. The findings revealed that most students think doing experiments is very important for learning Chemistry. They also found that how much importance students place on research in chemistry learning depends a lot on how much they participate in lab work.

In the article "Artificial intelligence in chemistry" by N.A.B Gray (1988), it's mentioned that they review the methods and tools of artificial intelligence. Chemical problems are seen as good areas to test new artificial intelligence methods. Artificial intelligence techniques can be used to solve real-life chemistry problems. In chemistry, these techniques can help with tasks that need chemical knowledge, as well as tasks where chemistry is just one part of the problem. Programs that use encoded chemical knowledge can help solve problems like figuring out chemical structures, planning synthesis, and designing experiments. Robotics methods that use artificial intelligence and expert systems can make chemical instruments work better. Systems that understand human language could make it easier to deal with chemical information, and artificial intelligence techniques could make computer-based teaching even better.

In their paper titled "Artificial Intelligence Generative Tools and Conceptual Knowledge in Problem Solving in Chemistry" Wajeeh Daher, Hussam Diab, and Anwar Rayan (2023) discuss how artificial intelligence (AI) has become increasingly important in education and problem-solving. They focus on the use of ChatGPT, an AI tool, to support learning in chemistry. The researchers examined the challenges ChatGPT faces in understanding and responding to chemistry problems related to “Introduction to Material Science”. Using a framework proposed by Holme et al., which covers areas like transfer, depth, prediction/explanation, problem-solving, and translation, they assessed ChatGPT's understanding of concepts. The scientists presented ChatGPT with thirty chemistry problems from the Introduction to Material Science field and asked it to provide solutions. They concluded that ChatGPT struggled with understanding conceptual knowledge, particularly in areas like representations and depth, which hindered its ability to effectively transfer knowledge.

In their article "Evaluating Academic Answers Generated Using ChatGPT" American scientists Suzanne Fergus, Michelle Botha, and Mehrnoosh Ostovar (2023) explore the use of technology in education, especially amid the COVID-19 pandemic. They focus on Chat Generative Pre-Trained Transformer (ChatGPT), an AI technology that generates conversational responses based on user prompts. This study aims to understand how ChatGPT performs in answering chemistry assessment questions and its potential impact on learning and assessment. The researchers examined two chemistry modules in a pharmaceutical science program's first and second years, comparing ChatGPT-generated responses to end-of-year exam assessments. They found that ChatGPT performed well in answering questions that required knowledge and understanding but faced limitations in questions that demanded application of knowledge and interpretation of non-textual information. The study also assesses the

quality of ChatGPT responses and concludes that it poses a low risk of cheating. Additionally, the researchers suggest that ChatGPT discussions could prompt conversations about academic integrity and assessment design, similar to the educational discussions sparked by the COVID-19 pandemic.

Wajeeh Daher, Hussam Diab, and Anwar Rayan (2024) explored the growing use of generative artificial intelligence tools in different fields, especially education, in their article "Generative Artificial Intelligence in Chemistry Problem Solving across Versions and Languages". They focused on ChatGPT versions 3.5 and 4.0, which are known for their ability to understand multiple languages, aiding both students and teachers. Their research aimed to compare the performance of these versions, specifically looking at how accurately ChatGPT answered questions in English compared to Arabic. They tested ChatGPT with 39 chemistry problems typically found in 6th-7th grade curriculum, consisting of both open-ended and multiple-choice questions. They categorized each response as accurate, partially accurate, or inaccurate. Their analysis revealed significant improvements in version 4.0, especially in handling Arabic. However, despite these enhancements, the study found that ChatGPT's responses in English were consistently more accurate than those in Arabic. To address this issue, they proposed either including more Arabic data during training or implementing a method where questions are first translated from Arabic to English, answered, and then translated back into Arabic for users. This approach leverages the higher accuracy of English responses to benefit Arabic-speaking users and potentially improves outcomes for users in other languages, especially in science education contexts like chemistry.

The next research work is Mary E. Emenike and Bright U. Emenike (2023) article " Was This Title Generated by ChatGPT? Considerations for Artificial Intelligence Text-Generation Software Programs for Chemists and Chemistry Educators". They discuss the concerns raised by the release of ChatGPT, a free text-based system developed by OpenAI, especially regarding honesty in academics and how students are evaluated across different levels of education. However, they believe that these systems can have a bigger impact beyond just teaching and learning chemistry. According to their research, artificial intelligence systems like ChatGPT can be useful for students, teachers, and school administrators in various ways such as teaching, research, and professional activities. They explore different ways students and teachers might use ChatGPT, highlighting both the advantages and potential problems, and also considering fairness and accessibility issues. For example, students can use ChatGPT to get help with tasks like answering questions on assignments, writing lab reports, doing research, studying, and getting tutoring assistance. Meanwhile, teachers can use it for teaching purposes such as creating assessment items, preparing class materials, conducting research, and managing professional aspects like their career and speaking engagements. They aim to encourage productive discussions on how to make the best use of artificial intelligence technology while being aware of its limitations.

The same thing in the article “Proposal to integrate artificial intelligence tools in chemistry teaching in higher education” by the authors R. Perezzan, S. Montalvo-Quirós, R. Rama-Ballesteros, D. Herráez-Aguilar(2024). In today's education, Artificial Intelligence (AI) is becoming increasingly important, especially in Natural Sciences like Chemistry. This study proposes using AI tools such as ChatGPT 3.5, Microsoft Bing, and Wolfram Alpha to enhance learning in Chemistry. These tools help students understand complex concepts and improve their ability to learn independently. Students can ask the AI questions and discuss the answers with their teacher to improve critical thinking skills. This approach not only improves Chemistry learning but also prepares students for academic and professional challenges. By integrating AI into teaching, education becomes more modern and adaptable to current

demands. AI tools facilitate a more interactive and effective learning experience, allowing students to explore concepts independently and creatively. Ultimately, the integration of AI in higher education offers new opportunities for deeper learning and better preparation for the modern world.

The upcoming paper, "The Limitations and Potential of ChatGPT in Chemistry Education " by Thu Nguyen and Yanika Sirichokcharoenkun (2023), delves into the drawbacks and potential of using ChatGPT in chemistry education. It explores how ChatGPT, a type of chatbot powered by language processing technology, has become popular in various educational fields, including chemistry. The authors analyze its limitations, such as its struggle with understanding context, inability to interpret visuals, and lack of specialized training data. They also highlight its benefits, including providing personalized help, fostering critical thinking, and supporting self-paced learning. However, they also acknowledge challenges like accuracy issues and ethical concerns. The paper concludes by offering suggestions for educators and developers to maximize ChatGPT's benefits while minimizing its drawbacks in chemistry education.

Summarizing the above information, the impact of artificial intelligence in teaching chemistry was discussed and literature research was conducted. The purpose of this study is to search for the use of AI in chemistry education. The research question is “which activities with AI are used in chemistry instruction”.

Methodology

A literature review research method was used to carry out the research. About 10 works of foreign and domestic scientists written on AI in chemistry education were studied. These articles were about the AI in chemistry education, the advantages and disadvantages of AI and impact to the study. Research works of scientists were taken from the Google Scholar platform. Keywords such as AI, chemistry education and AI in chemistry education were used to search for the article. The scientific articles were shown in the following table (Table 1). Each activity with frequency and percentage calculation as analysis method.

Article	Number
Vladimir L. Kodkin & Ekaterina V. Artemeva(2024); Ted M. Clark(2023); Margarida Figueiredo & M. Lurdes Esteves(2014); N.A.B Gray (1988); Wajeeh Daher, Hussam Diab & Anwar Rayan (2023); Suzanne Fergus, Michelle Botha & Mehrnoosh Ostovar(2023); Wajeeh Daher, Hussam Diab & Anwar Rayan(2024); Mary E. Emenike & Bright U. Emenike(2023); R. Perezzan, S. Montalvo-Quirós, R. Rama-Ballesteros & D. Herráez-Aguilar(2024); Thu Nguyen and Yanika Sirichokcharoenkun(2023)	10 articles

Table 1. Presentation name of the searched articles

Result

After extensive data collection, it was determined that artificial intelligence can be applied to 4 types of activities in chemistry education. The results of the research are shown in Table 2. The table provides a list of types of activity that can be created by artificial intelligence and research articles, frequency and percentage in the literature.

The most common activities identified were answering questions and solving problems (70%). This indicates that students use artificial intelligence to assist with learning chemistry through these methods. The least common activities included laboratory work (20%) and making scientific predictions (20%), such as writing research papers. These tasks tend to be more interesting to college and university students.

Activity name	Article (author, Year)	Frequency	Percentage
Creating and solving open-ended and multiple-choise questions	Vladimir L. Kodkin, Ekaterina V. Artem'eva(2024); Ted M. Clark(2023); Wajeeh Daher, Hussam Diab, and Anwar Rayan(2024); Mary E. Emenike and Bright U. Emenike(2023)	4	40%
For Studying Chemistry(answering questions, solving problems)	Vladimir L. Kodkin, Ekaterina V. Artem'eva(2024); N.A.B Gray (1988); Wajeeh Daher, Hussam Diab, and Anwar Rayan (2023); Suzanne Fergus, Michelle Botha, and Mehrnoosh Ostovar(2023); Mary E. Emenike and Bright U. Emenike(2023); R. Perezzan, S. Montalvo-Quirós, R. Rama-Ballesteros, D. Herráez-Aguilar(2024); Thu Nguyen and Yanika Sirichokcharoenkun(2023)	7	70%
For Scientific Assumptions	Vladimir L. Kodkin, Ekaterina V. Artem'eva(2024); Mary E. Emenike and Bright U. Emenike(2023)	2	20%
Laboratory works	Margarida Figueiredo, M. Lurdes Esteves, José Neves and Henrique Vicente(2014); Mary E. Emenike and Bright U. Emenike(2023)	2	20%

Table 2. Activities with frequency and percentage

Conclusion

At the end of the study, 10 different articles on "AI in chemistry education" were analyzed, identifying four types of activities. The main activities include creating and solving both open-ended and multiple-choice questions (40%), and answering questions and solving problems (70%). As suggestions for further research, I recommend developing a chemistry database for AI to help answer complex questions accurately; creating a chemistry AI app that consolidates all necessary information; and developing methods to calculate chemical problems using mathematical formulas. This should also include inputting these methods into AI to create tasks that are different in formula and calculation but

have the same final meaning. Implementing these recommendations could significantly enhance students' chemistry skills and academic integrity.

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EXPLORING THE EFFICACY OF VIRTUAL LABORATORY SIMULATIONS IN ENHANCING STUDENT LEARNING OUTCOMES

Abstract. Virtual laboratory has become an essential tool to provide Physics subject.VL can be a great accelerator for delivering complicated and abstract topics in Physics.The study was performed to understand if a virtual laboratory-based teaching method is effective on student's academic achievement in Physics lesson.This study concentrated on academic performance of grade 8 students of Al Farabi lyceum, school year 2023-2024.The method used in the article is quasi-experimental.The sample divided to experimental group and control group.In the EG lessons provided by using VL and in the CG provided as traditional lesson.To measure students academical achievement participants passed pre-post tests. The study's findings suggested that students learning outcomes might be enhanced by simulation-based activities. Furthermore, it was shown that the majority of students thought highly of the virtual laboratory activities.

Keywords: Digital literacy, virtual laboratory, computer-based learning, student achievement

Introduction

Virtual laboratories have emerged as a valuable tool in the field of physics education, providing students with the opportunity to conduct experiments in a simulated environment. These virtual laboratories offer several advantages over traditional laboratories, such as cost-effectiveness, accessibility, and flexibility (Hunt, 2005).One study conducted by researchers found that virtual laboratories are widely implemented in universities, particularly in disciplines such as engineering, computer science, and information assurance.The use of virtual laboratories in physics education has been particularly beneficial in distance education courses, where logistical challenges and high costs often limit the ability to perform real experiments. Furthermore, virtual laboratories provide an alternative solution to address the lack of equipment or space constraints faced by physics students. These virtual laboratories are designed to parallel the theoretical and computational framework introduced in traditional lectures, providing students with hands-on experience and reinforcing their understanding of physics concepts. In the area of chemistry, the implementation of Connected Chemistry through virtual simulations has shown promising results in terms of student achievement.Similarly, a study conducted in the field of biology found that computer simulations for sustainable education led to quantitative improvements in student achievement.Additionally, research has shown that virtual laboratories can facilitate the understanding of complex concepts and improve representational skills in science subjects such as chemistry.There is also a strong demand from students for real-life applications and connections to be included in the virtual laboratory directions.Overall, the literature suggests that virtual laboratories have shown effectiveness and potential in physics education (García-Martínez et al., 2023).These virtual laboratories provide a cost-effective and accessible alternative to traditional laboratories, especially in distance education courses or situations where equipment is lacking or prohibitively expensive. Furthermore, they have been shown to improve student achievement and understanding of complex concepts. Virtual laboratories have shown effectiveness and potential in physics education, offering

several advantages over traditional laboratories such as cost-effectiveness, accessibility, and flexibility. Furthermore, the use of virtual laboratories can provide students with the opportunity to explore and experiment with physics concepts in a safe and controlled environment. The general purpose of the article is to check the impact of the virtual laboratory on the quality of students' education. The specific steps to be taken to implement this research:

1. Division of research participants into two groups: experimental and control group.
2. Taking pre-test from participants before starting the research work.
3. The main part of the study is to explain the lesson to the experimental group through a virtual laboratory, and to the control group using the traditional method.
4. Taking post-test from both groups.
5. Deriving results from the obtained results.

Methods

The participants of the study were 52 grade 8 students of Al Farabi lyceum, which 29 were females, 23 were males. The sample divided to experimental group and control group. From among the school's classes, two were chosen, one to act as an experimental group and the other as a control group. 26 pupils in the experimental group studied science with the use of virtual lab learning that the researchers had created especially for this study. 26 students studying science in a typical Physics classroom—the traditional manner of instruction—made up the control group. In this study used the convenient sampling method and participants chosen to determine the effectiveness of virtual-based learning on their academical achievement.

The following instruments were used in this study:

1. A virtual laboratory experiment focusing on the concept of Electricity;
2. Achievement pre-test and post-test;

The quasy-experimental research method of the study used the correlational model. It aimed to find out if there is a relationship between virtual laboratory-based learning and their academic performance. The teaching approach (virtual lab versus interactive demonstrations using real lab equipment) was the independent variable in this study. The conceptual knowledge and attitudes of the students toward physics were the dependent variables. This was followed by the construction of pre-test and post-tests, which were administered to selected students. After that, respondents were given a pre-test, after which virtual laboratory-based learning was carried out. After two weeks, conducted a post-test to check how well the students understood the published competencies. The results of the tests performed at the end of the study and were analyzed by Jamovi software by using paired t-test analyzes to analyze participant outcomes. The correlation between pre-test and post-test two test will be gotten to certain the effectiveness virtual laboratory -based learning.

Pre -test	Group	Method	Post-test
Achievement Test	Experimental	Virtual laboratory (Phet Colorado)	Achievement Test

Achievement Test	Control	(Conventional method)	Achievement Test

Table 1. Research design

Results and discussion

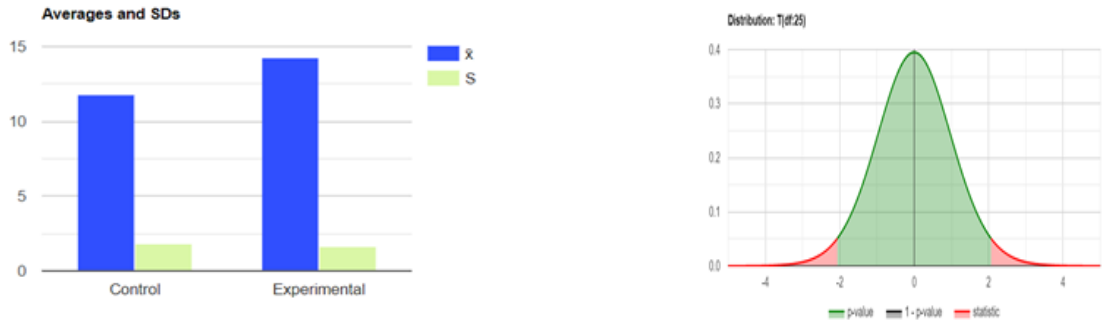

Table 3- Distribution T (df:25)

Results of the paired-t test indicated that there is a significant large difference between Control (M = 11.8, SD = 1.8) and Experimental (M = 14.3, SD = 1.7), $t(25) = 9.1$, $p < .001$. The sample difference between the averages of Experimental and Control is big enough to be statistically significant. Research has shown that students who engage with virtual laboratories demonstrate improved understanding of scientific concepts and increased retention of knowledge compared to those who only engage in traditional laboratory settings.

Research findings consistently demonstrate that students who actively engage with virtual laboratories exhibit a deeper understanding of scientific concepts compared to their counterparts in traditional laboratory settings. These virtual environments enable students to manipulate variables, observe outcomes, and conduct experiments in a controlled yet interactive manner, fostering an immersive learning experience.

Conclusion

In conclusion, we found that using Virtual laboratory is effective in teaching Physics. Based on the results of this study, it seems clear that the use of VL increased student achievement levels and had a positive effect on students' Physics.The study showed that there is significant correlation between students academical performances after using virtual laboratory-based learning.

We may infer that virtual laboratories are a useful tool for improving students' understanding of science subject and that they are suitable for conducting real-world experiments using topics connected to electricity. Virtual laboratories must therefore be included in the science curriculum. Additionally, educators ought to be urged to utilize the virtual labs that are accessible, as they aid in pupils' comprehension and provide several opportunities for experience with inquiry.

If the findings of this study can be applied to other research populations, more research with students at various educational levels should be conducted. The quantitative results of this study, which

examined the efficacy of virtual labs, were constrained, and additional research utilizing qualitative techniques might be required.

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HARDWARE AND SOFTWARE TOOLS IN CHEMISTRY EDUCATION

Abstract. This review explores the impact of technology on chemistry education. Augmented reality (AR) offers interactive learning experiences, while smartphones provide hands-on experimentation tools. Virtual reality (VR) platforms simulate field trips for environmental chemistry. Educational software, like CocoSoft, automates analytical chemistry processes. The integration of computational chemistry tools and virtual simulations bridges theory with practice. This review highlights the benefits and challenges of technology in chemistry education, emphasizing its potential to improve learning and readiness for a technology-driven world.

Keywords: Technology, hardware, software, integrative chemistry, chemistry teaching

Introduction

In recent years, the integration of technology into chemistry education has seen a significant surge, revolutionizing traditional teaching methods and enhancing student engagement. This transformation is evidenced by the exploration of various technological tools such as augmented reality (Abdinejad et al., 2021; Irwansyah et al., 2018), smart devices (Williams & Pence, 2011), virtual reality platforms (Fung et al., 2019), and educational software (Cocovi-Solberg & Miró, 2015; Lancashire, 2000). These advancements have not only provided innovative avenues for delivering educational content but have also facilitated interactive learning experiences (Jammeh et al., 2023). Furthermore, the integration of computational chemistry tools (Esselman & Hill, 2016; Kind et al., 2009) and virtual simulation technologies (Li et al., 2021; Kobayashi et al., 2021) has contributed to bridging the gap between theoretical concepts and practical laboratory applications, offering students hands-on experiences even in remote settings. This article explores the multifaceted landscape of technology integration in chemistry education, shedding light on its benefits, challenges, and future prospects.

Literature review

The integration of technology into chemistry education has garnered considerable attention from researchers and educators alike, with a growing body of literature highlighting its diverse applications and benefits. A notable area of exploration involves the utilization of augmented reality (AR) and 3D visualization technologies, as demonstrated by Abdinejad et al. (2021), who examined student perceptions in chemistry education. Their findings underscored the potential of AR in enhancing students' understanding of complex chemical concepts by providing immersive and interactive learning experiences.

Similarly, the efficacy of smart devices in the chemistry classroom has been investigated by Williams and Pence (2011). Their study emphasized the transformative role of smartphones as powerful tools for facilitating hands-on experimentation, data collection, and visualization, thereby enhancing students' engagement and learning outcomes.

In the realm of virtual reality (VR), Fung et al. (2019) explored the application of VR platforms in environmental chemistry education. By simulating field trips to overseas sites, VR technology offered students an immersive learning experience, transcending geographical constraints and fostering experiential learning opportunities.

Moreover, the integration of educational software has been recognized as a valuable resource for enhancing teaching and learning in chemistry. Cocovi-Solberg and Miró (2015) introduced CocoSoft, an educational software designed to automate analytical chemistry laboratory processes, thereby streamlining laboratory workflows and improving efficiency.

Beyond specific technologies, researchers have also investigated broader themes such as technology attitudes among pre-service chemistry teachers (Yavuz, 2005) and the self-efficacy beliefs of chemistry educators regarding technological tools (Blonder et al., 2013). These studies shed light on the importance of addressing educators' perceptions and readiness to integrate technology effectively into their teaching practices.

Furthermore, the emergence of open-source software has democratized access to computational chemistry tools, enabling broader participation and collaboration in research and education (Lehtola & Karttunen, 2022; Kind et al., 2009). This democratization has paved the way for innovative approaches to teaching and research, empowering students and educators to explore complex chemical phenomena in virtual environments.

Purpose: The purpose of this study is to identify the efficient technological tools in chemistry instruction.

Research question: What kind of hardware and software are used in chemistry education?

Methodology

Research Design

The research process begins with the identification of relevant search terms and keywords, guided by the research focus on technology integration in chemistry education.Google Scholar is utilized as the primary search engine for academic literature, given its comprehensive coverage of scholarly publications across disciplines.Keywords such as "chemistry education," "technology integration," and specific technology terms (e.g., "augmented reality," "virtual reality") are entered into the search bar to retrieve relevant articles.

Sampling.

Author, year of publication	Description
M. Abdinejad, B. Talaie, H. S. Qorbani, S. Dalili (2021)	This study examines student views on augmented reality (AR) and 3D visualization in chemistry education.
A. J. Williams, H. E. Pence(2011)	They investigate the potential of smartphones as effective tools for hands-on experimentation, data gathering, and visualization in chemistry education.
Fung, F. M., Choo, W. Y., Ardisara, A., Zimmermann, C. D., Watts, S., Koscielniak	Published in 2019, this study shows how VR enhances environmental chemistry education by simulating overseas field trips, offering immersive learning experiences and improving student understanding and engagement.
Blonder, R., Jonatan, M., Bar-Dov, Z., Benny, N., Rap, S., & Sakhnini, S. (2013)	Looking into the effects of equipping chemistry teachers with tech tools, this study delves into boosting their self-confidence. The research examines how platforms like YouTube can enhance teachers' comfort in using technology, providing insights into technology's role in improving chemistry educators' efficacy.

A. L. Jammeh, C. Karegeya, S. Ladage (2023)	Exploring the integration of SMART notebook software in chemistry education, this study focuses on creating interactive classroom experiences.
Z. Li, Y. Cao, J. Luo (2021)	Examining the use of virtual simulation technology in chemistry teaching, this study explores its potential benefits and applications, offering insights into its effectiveness for educators and students.
R. J. Lancashire (2000)	The article explores how leveraging the Internet as a teaching tool enhances access to resources, collaboration, and interactive learning experiences for both educators and students in the field of chemistry.
D. J. Cocovi-Solberg, M. Miró (2015)	Exploring CocoSoft, this study focuses on educational software designed for automation in the analytical chemistry laboratory. It likely discusses how this tool improves efficiency and learning experiences in analytical chemistry education.
W. Yu, L. Chen (2012)	Examining the use of computer software in chemistry teaching, this study likely discusses how these tools enhance the learning experience.

Data collection

During the research, I utilized Google Scholar to search for articles related to the integration of technology in chemistry education. I focused on keywords such as "chemistry education," "technology integration," and specific technologies mentioned in the provided references, such as "augmented reality," "virtual reality," and "educational software.

After conducting initial searches, I explored various academic databases, including PubMed, Scopus, and Web of Science, to identify additional relevant literature. This comprehensive search strategy ensured that a wide range of sources were considered for inclusion in the analysis.

Each article retrieved from the searches was critically evaluated based on its relevance to the research topic and its potential to contribute valuable insights. Special attention was given to articles that

specifically addressed the integration of technology in chemistry education, as well as those that provided empirical evidence or practical applications of technological tools in educational settings.

The selection criteria for inclusion in the analysis were based on the article's publication date, language (English), and its focus on technology integration in chemistry education. Non-peer-reviewed sources and publications not directly related to the research topic were excluded from consideration.

After reviewing the articles, relevant data were extracted, including author names, publication year, journal title, article title, and key findings related to the integration of technology in chemistry education. This data collection process helped ensure that only high-quality and pertinent articles were included in the analysis, contributing to a comprehensive understanding of the role of technology in enhancing chemistry education.

Data analysis

Throughout the study, the focus was on analyzing the integration of various technological tools and approaches in chemistry education. The analysis aimed to uncover the frequency of each technological tool's mention in the literature and determine the percentage of articles discussing their effectiveness and implementation strategies.

Result

As the result, in the reviewed literature on technology integration in chemistry education, Augmented Reality (AR) was discussed in 10% of articles (two studies), Virtual Reality (VR) was represented in 5% of articles (one study), Educational Software was found in 15% of articles (three studies), Computational Chemistry was featured in 15% of articles (three studies), Virtual Lab was discussed in 10% of articles (two studies), YouTube was addressed in 5% of articles (one study), and General Technology Integration was mentioned in 15% of articles (three studies).

In the findings from the literature, the efficient technological tools in chemistry instruction were identified. These are presented in Table 2.

Name of tools	Name of article	Frequency	Percentage
Augmented Reality (AR)	Abdinejad, M., Talaie, B., Qorbani, H. S., & Dalili, S. (2021). Irwansyah, F. S., Yusuf, Y. M., Farida, I., & Ramdhani, M. A. (2018, January).	2	10 %
Virtual Reality (VR)	Fung, F. M., Choo, W. Y., Ardisara, A., Zimmermann, C. D., Watts, S., Koscielniak, T., ... & Dumke, R. (2019).	1	5 %

Educational Software	Cocovi-Solberg, D. J., & Miró, M. (2015). Yu, W., & Chen, L. (2012). Jammeh, A. L., Karegeya, C., & Ladage, S. (2023).	3	15 %
Computational Chemistry	Lehtola, S., & Karttunen, A. J. (2022). Kind, T., Leamy, T., Leary, J. A., & Fiehn, O. (2009). Esselman, B. J., & Hill, N. J. (2016).	3	15 %
Virtual lab	Li, Z., Cao, Y., & Luo, J. (2021). Kobayashi, R., Goumans, T. P., Carstensen, N. O., Soini, T. M., Marzari, N., Timrov, I., ... & Talirz, L. (2021).	2	10 %
YouTube	Blonder, R., Jonatan, M., Bar-Dov, Z., Benny, N., Rap, S., & Sakhnini, S. (2013).	1	5 %
General Technology Integration in Chemistry Education	Belford, R. E., & Gupta, T. (2019). Reyes, P. B., & Silang, Z. D. (2021). Gupta, T., & Belford, R. E. (2019).	3	15%

Table 2. Technological Tools Used in Chemistry Instruction

This table provides a summary of various tools used in chemistry education, along with the frequency of their mentions in the literature. The "Name of Tools" column lists the specific tools, such as Augmented Reality (AR), Virtual Reality (VR), Educational Software, Computational Chemistry, Virtual Lab, YouTube, and General Technology Integration. The "Name of Article" column lists the articles where these tools are mentioned. The "Frequency" column indicates how many times each tool

is referenced in the literature, and the "Percentage" column shows the percentage of the total mentions that each tool represents.

Conclusion

The integration of technology in chemistry education has revolutionized teaching methods, enhancing student engagement and understanding. Augmented reality (AR), virtual reality (VR), educational software, and computational chemistry tools have all shown promise in providing immersive learning experiences. From smartphones enabling hands-on experimentation to VR platforms offering virtual field trips, these technologies bridge theory and practice. Despite challenges, such as access, they hold the potential to prepare students for a technology-driven future. Continued research and innovation in technology integration are key to advancing chemistry education.

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ҚАЗАҚ ТІЛІ САБАҚТАРЫНДА ИНФОГРАФИКА ҚОЛДАНУДЫҢ ТИІМДІЛІГІ

Аңдатпа. Мақалада қазақ тілі сабағында оқу материалдарын инфографиканың көмегімен визуалдаудың тиімді тұстары, жолдары қарастырылады. Инфографика – оқушыларға күрделі ұғымдарды түсінуге оңай, көрнекі түрде көрсетуді қамтамасыз ететін құрал. Білім алушыларға ақпаратты жақсырақ түсінуге, есте сақтауға, олардың проблемаларды шешу дағдыларын жақсартуға және шығармашылық қабілеттерін арттыруға визуализацияның көмектесетіні белгілі. Мақалада инфографиканың оқушылардың белсенділігіне, білімді меңгеруіне және есте сақтауына әсері қарастырылады.

Түйін сөздер: қазақ тілі, визуалдау, инфографика, оқыту әдістемесі

Қазіргі кезде тұтынатын ақпарат көлемі де, ақпарат алмасу жылдамдығы да айтарлықтай өсті. XX ғасырдың аяғында өмір сүрген адамның бір аптада тұтынған ақпараты жүзжылдықтың басында өмір сүрген адамның ғұмыр бойы тұтынған ақпаратынан асып түседі. Білім беруде де бұрындары мұғалімдер, кітаптар жалғыз ақпарат көзі болса, XXI ғасырда ғаламтор бүкіл адамзат тарихында жиналған ақпаратты қолжетімді етті.

Ақпараттың көбеюімен оны қабылдау да қиындай түсті. Нейробиолог Дэниель Левитин “Организованный ум: мышление в век информационной перегрузки” кітабында зейінді адам ағзасындағы маңызды менталды ресурстардың бірі деп атап, адам миының зейінді шоғырландыру қабілетінің шектелуін қазіргі қоғамның басты мәселесі деп көрсетеді (Левитин Д).

Технологияның қарыштап дамыған заманында білім алушылардың да зейінін оқуға шоғырландыру күрделене түсті. Тек оқулықпен оқыту, тақтаға жазып түсіндіру, мұғалімнің ауызша баяндауы, т.б секілді ақпаратты ұсынудың дәстүрлі түрлері жеткіліксіз. Себебі жаңа буын өкілдері, яғни Z, альфа ұрпақ клиптік ойлауға бейімделгендіктен, оқу материалдарын визуалды түрде ұсыну тиімді болмақ.

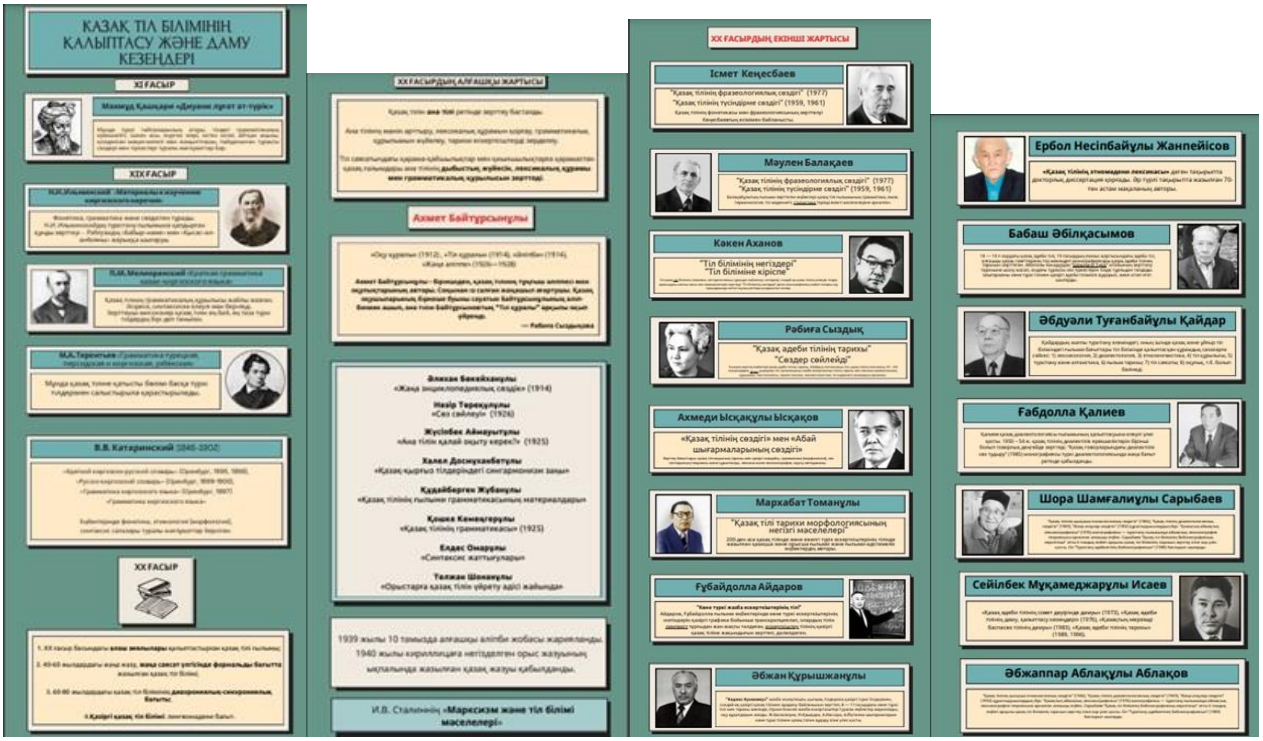
Визуалдау — сандық және мәтіндік ақпаратты барынша түсінікті және меңгеруге оңай болатындай көрнекі түрде ұсыну. Ақпаратты визуалдау үшін флипбук, презентация, ақыл-ой картасы, инфографика, постер, т.б цифрлық құралдар қолданылады. Осы орайда мақаламызға нысан ретінде, қазақ тілі сабағында ақпаратты визуалдаудың құралы, оқытудағы тиімді тәсіл ретінде инфографиканы алып отырмыз.

Инфографика (лат. тілінен informatio хабардар болу, нақтылау, көрсету; грек тілінен grafikos жазбаша, жазу) - күрделі ақпараттың қарапайым және тартымды нұсқадағы визуалды мазмұны. Инфографика ақпарат пен суреттің үйлесім табуымен ерекшеленеді. Инфографика медиа, дизайн салаларында кең қолданылады. Білім беру үдерісіне де қарқынды еніп, ғылыми-зерттеу жұмыстарына тақырып ретінде де қарастырылуда.

Инфографика білім алушылардың қызығушылығын оятып, ақпаратты дұрыс жүйелеуге, талдауға және синтездеуге көмектеседі. Күрделі ақпаратты оңтайландырып, оқырман интерпретациясына жол ашады. Сондай-ақ визуалды, креативті ойлау дағдыларын жетілдіреді.

Инфографиканың ақпарат мазмұнына қарай статистикалық, ақпараттық, географиялық, салыстырмалы, иерархиялық, хронологиялық және процедуралық секілді бірнеше түрі бар (Жиленко О., Климова В, 2017: 39). Оларды қазақ тілін мектеп оқушыларына оқыту үшін де, ЖОО-да студенттерді оқыту үшін де қолданса болады.

Егер сіз бір құбылыстың, заттың тарихын айтқыңыз келсе, маңызды күндерді белгілегіңіз келсе, оқиғаларға шолу жасағыңыз келсе, хронологиялық инфографиканы қолдану тиімді болмақ. Адамдар уақыт пен кеңәстік ұғымын байланыстыратындықтан, хронологиялық инфографика белгілі бір уақыт кезеңінің анық бейнесін көрсетуге көмектеседі. Мәселен, студенттерге қазақ тіл білімінің қалыптасуы мен даму кезеңдерін түсіндіру үшін хронологиялық инфографиканы қолдану тиімді. Инфографиканың бұл түрі оқиғалар тізбегін, орын алу кезегін, бір құбылыстың қалыптасып, даму кезеңдерін көрсету үшін қолданылады. Төмендегі хронологиялық инфографикадан қазақ тіл білімінің қай ғасырда қалыптаса бастағанын, уақыт өте келе қалай дамығанын, кімдер зерттегенін, қандай еңбектер жазылғанын көруге болады. Бұл білім алушының миында түсіндіріліп жатқан құбылыстың толық бейнесі қалыптасып, есте сақтауына мүмкіндік береді.



Ал ақпараттық инфографиканы кез келген жаңа тақырыпты оқытқанда, ережелерді түсіндіргенде қолдануға болады. Мысал ретінде берілген көсемше жайлы ақпараттық инфографикада көсемшенің анықтамасы, қолданысы, жасалу жолдары және сөйлемдегі қызметі қабылдауға жеңіл, жүйелі түрде берілген. Инфографикаға қарап-ақ, бірінші кезекте қай ақпаратқа назар аудару керектігін, одан кейін қай ақпаратты оқу керектігін оңай түсінуге болады. Ақпараттық инфографика арқылы мәліметті жеңіл әрі тартымды етіп беріп қана қоймай, білім алушының визуалды ойлауын дамытып, ақпаратты есте сақтау қабілетін арттыруға болады. Ақпараттық инфографикада қаріп пен кескіндердің өлшемі мен стилі маңызды. Оқырманның көзін дәйекті түрде бағыттау үшін беттегі нысандардың орналасуы да маңызды.

Инфографиканың тағы да бір түрі - салыстырмалы инфографика. Бұл формат бірнеше нысанды, адамды, тұжырымды, өнімді немесе брендтті салыстыру үшін пайдалы. Бұлай салыстыру екі нысанның ұқсастықтар мен айырмашылықтарын көрсетуге көмектеседі. Әдетте, салыстырмалы инфографика тігінен немесе көлденеңнен екіге бөлініп, әр жағында әр заттың не құбылыстың айырмашылықтары көрсетіледі. Берілген салыстырмалы инфографикада дауысты және дауыссыз дыбыстың айырмашылығы көрсетілген.

Инфографикаға қарап, білім алушылар дауысты дыбыс пен дауыссыз дыбыстардың айырмашылығын оңай меңгереді. Олардың қай жағынан салыстырылып тұрғанын түсінеді.

Қорыта айтқанда, инфографика - оқу материалын жеңіл әрі тартымды етіп беретін, көлемді ақпаратты шағын, бірақ мазмұнды түрде ұсынуға мүмкіндік беретін, білім алушылардың оқу материалын игеру тиімділігін арттыратын, олардың қызығушылығын оятатын, визуалды және креативті ойлауын дамытатын құрал. Қазақ тілі сабағында да оқу материалын инфографиканың көмегімен ұсыну тиімді. Атап айтқанда, ақпараттық, салыстырмалы, хронологиялық инфографика фонетика мен грамматика ережелерін, қазақ тілінің дамуын түсіндіру үшін пайдаланыла алады.

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«ПРЕПОДАВАНИЕ ГЕНЕТИКИ С ИСПОЛЬЗОВАНИЕМ СИСТЕМ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА: ПРЕИМУЩЕСТВА И НЕДОСТАТКИ»

Аннотация. Искусственный интеллект (ИИ) способен революционизировать образование, улучшая качество обучения учащихся и помогая преподавателям в их практической деятельности. Используя методы ИИ, такие как интеллектуальные системы обучения, виртуальные ассистенты и аналитика данных, классы могут стать более персонализированными, привлекательными и эффективными. Учащиеся получают выгоду от персонализированных

методов обучения, адаптивной обратной связи и возможностей для совместной работы, что приводит к улучшению понимания, развитию навыков критического мышления и самостоятельному обучению. Преподаватели, с другой стороны, могут автоматизировать административные задачи, получать информацию об успеваемости учащихся на основе данных и внедрять индивидуальные стратегии обучения. Интеграция искусственного интеллекта в образование обещает улучшить результаты обучения, повысить эффективность и преобразовать образовательный опыт для всех заинтересованных сторон.

Ключевые слова: Искусственный интеллект, образование, генетика, преимущес

Введение

Генетика - это научная область, которая изучает сходства (наследственность) и различия (вариации) между родителями и их потомством. Его цель - понять, как характеристики индивидуумов наследуются от их родителей и передаются из поколения в поколение (Akinnubi et al., 2012: 16). Последние достижения в области генетики обещают улучшить диагностику, лечение и профилактику заболеваний. Как подчеркнул Озкан (Ozcan, 2014: 3187), прогресс в области генетики, молекулярной биологии и биотехнологии внес значительный вклад в улучшение жизни человека. Знания в области генетики играют ключевую роль в развитии таких областей, как киберфизические системы и молекулярная биология, которые считаются катализаторами четвертой промышленной революции (4IR) (Maynard, 2015). Учитывая критическую важность генетики, во всем мире существует потребность в опытных генетиках. Их опыт имеет решающее значение для борьбы с более чем 10 000 заболеваний человека и инфекций, возникающих в результате генетических мутаций (Goy et al., 2019; World Health Organization, 2018). Эти мутации создают серьезные проблемы для здоровья во всем мире, и генетики также играют жизненно важную роль в тестировании ДНК, клонировании, разработке генетически модифицированных организмов (ГМО), выявлении заболеваний (Choden & Kijkuakul, 2020), генетическом секвенировании и биологических исследованиях, а также в других областях. В современных научных исследованиях генетика остается фундаментальной и незаменимой темой (Choden & Kijkuakul, 2020: 445; Dorjee et al., 2017). Проблемы, связанные с обучением генетике, сохраняются в некоторых стенах университета из-за устаревших методов обучения и недостаточного использования современных образовательных технологий, таких как искусственный интеллект, дополненная и виртуальная реальность (AR и VR), робототехника и другие. Мы предполагаем внедрение технологий искусственного интеллекта, в частности интеллектуальных обучающих систем (ITSS), для улучшения преподавания и изучения генетики. Это передовые инструменты на базе искусственного интеллекта, способные обеспечить индивидуальное руководство и поддержку учащимся. Они достигают этого, оценивая успеваемость и поведение учащихся и автоматически предоставляя соответствующую обратную связь.

Цель данной статьи состоит в определении влияния искусственного интеллекта (ИИ) на образование и представлении всестороннего обзора данной темы. Кроме того, мы планируем рассмотреть преимущества и недостатки использования ИИ в педагогике.

Искуственный интеллект в сфере образование

Мы должны признать, что цифровые технологии стали неотъемлемой частью нашей повседневной жизни. Эти технологии меняют то, как мы ищем информацию, общаемся друг с другом и даже ведем себя. В настоящее время, с развитием мировой науки и техники, технологии искусственного интеллекта также совершенствуются семимильными шагами. Технологии искусственного интеллекта постоянно обновляются и широко используются в различных областях (Jatileni et al., 2023; Sanusi et al., 2023a: 5967). Неоспоримым фактом является то, что искусственный интеллект все больше проникает в образовательную среду и учебный процесс. Процессе развития все больше людей обращают внимание на важность этой технологии в сфере образования. Искусственный интеллект широко используется в сфере образования и продемонстрировал существенные преимущества в применении, что оказывает глубокое влияние на учебный процесс и управление. В результате образовательная среда также претерпевает изменения. На самом деле, все больше и больше учебных заведений внедряют цифровую культуру в свои учебные планы. Например, во Франции даже в начальных школах предлагаются курсы по интернет-технологиям, в то время как старшеклассники должны сдавать экзамен, чтобы продемонстрировать свои навыки работы с компьютером. Кроме того, многие учебные заведения внедрили системы управления обучением, такие как Moodle, для облегчения процесса обучения.

В настоящее время в литературе можно найти множество определений ИИ. Согласно, “Искусственный интеллект - это деятельность, направленная на то, чтобы сделать машины интеллектуальными, а интеллект - это качество, которое позволяет организации функционировать надлежащим образом и с предвидением в окружающей среде”. Еще одно ключевое определение этой технологии представлено внизу:

• Искусственный интеллект - это “область компьютерных наук, занимающаяся решением когнитивных задач, обычно связанных с человеческим интеллектом, таких как обучение, решение задач и распознавание образов”.

• Искусственный интеллект - это “теория и разработка компьютерных систем, способных выполнять задачи, обычно требующие человеческого интеллекта, такие как визуальное восприятие, распознавание речи, принятие решений и перевод между языками”.

По всему миру запускается множество проектов, связанных с ИИ. В своем ежегодном отчете о новых технологиях компания Gartner представила информацию, описывающую появление ИИ на рынке как перспективную технологию. Согласно отчету, “способность использовать искусственный интеллект для улучшения процесса принятия решений, переосмысления бизнес-моделей и экосистем, а также для изменения качество обслуживания клиентов будет определять эффективность цифровых инициатив до 2025 года". Они также показали, что 59% организаций, вероятно, будут внедрять стратегии ИИ, а другие уже добились прогресса в пилотировании или внедрении решений с использованием ИИ. Это может относиться к различным областям, включая образование. С другой стороны, следует отметить, что основная причина, по которой компании и весь рынок хотят использовать ИИ в своей работе, заключается в том, что это выгодно, поскольку означает сокращение человеческих ресурсов и выплат заработной платы. Это одна из основных проблем, связанных с использованием ИИ в качестве сотрудника. Даже Стивен Хокинг (Griffin, A.,2015) и Илон Маск (Sulleyman, A., 2017) недавно предупреждали об угрозах, связанных с искусственным интеллектом.

Что касается сектора образования, то это не может вызывать большого беспокойства, поскольку всегда говорилось, что необходимыми составляющими эффективного обучения является взаимодействие с человеком и обществом.

В то же время это может значительно повысить уровень управления классом учителями и сделать управление классом более разумным и эффективным (Tuomi, 2018; Wang, 2020). С быстрым развитием современной науки и техники технология искусственного интеллекта также развивается. Результаты исследований в смежных областях позволили в дальнейшем применять искусственный интеллект в сфере образования, и он продемонстрировал хорошие прикладные результаты, способствуя реформированию преподавания.

В частности, растущая глобальная потребность стран в образовании своих граждан и необходимость разработки конкретной национальной политики возлагают значительную нагрузку на работников образования. Это привело к поиску альтернатив, включая массовое внедрение искусственного интеллекта в образовании. В результате появились разнообразные образовательные инструменты искусственного интеллекта, которые получили дальнейшее развитие, чтобы упростить их использование для поддержки учителей и их учеников в образовательных учреждениях. Интерактивные обучающие системы являются одной из наиболее распространенных форм образовательных технологий (EAIT), поскольку они могут обеспечивать персонализированную и автоматизированную обратную связь с преподавателями и учащимися. Широкое использование образовательных технологий привело к появлению новых форм взаимодействия между преподавателями и учащимися и значительно изменило традиционные отношения между преподавателем и учащимся, как показано на рисунке 2.

По мере того, как 21-й век переходит в 4-й, применение технологий искусственного интеллекта привело к появлению более совершенных информационных систем, которые представляют собой машины, способные имитировать и эффективно выполнять функции наставника-человека (Adelana & Akinyemi, 2021: 16). Искусственный интеллект в естественнонаучном образовании также широко используется для поддержки роли учителей в качестве фасилитаторов преподавания и обучения, методистов-консультантов, интеллектуальных систем репетиторства, специалистов по оценке успеваемости, поставщиков индивидуальной поддержки обучения и чат-ботов, среди прочего (Cukurova et al., 2021: 1). Когда искусственный интеллект применяется в традиционных классах естественнонаучного образования, улучшаются методы оценки в результате мгновенной обратной связи об успеваемости учащихся путем анализа их моделей обучения (Sanchez-Prieto et al., 2020: 80). На протяжении многих лет исследователи в области образования использовали технологию искусственного интеллекта для улучшения оценки и поддержки обучения по различным предметам STEM (D'Mello & Graesser, 2012: 145;). В 47 исследованиях, в которых использовались технологии искусственного интеллекта для научного образования было обнаружено, что технология искусственного интеллекта является высокоэффективной и проверенной альтернативой традиционным научным оценкам. Также сообщалось, что в естественнонаучном образовании, где от учащихся ожидают выполнения сложных педагогических задач, технология искусственного интеллекта смогла обеспечить поддержку, в том числе помочь учащимся в написании научных работ с использованием процессно-ориентированных подходов (Latifi et al., 2020; Walker, 2019: 227; Yang, 2021).

Преимущества искусственного интеллекта (ИИ)

Одним из главных преимуществ искусственного интеллекта (ИИ) является то, что его решения основаны на фактической информации, а не на эмоциональных соображениях. Хотя мы можем совершать ошибки и на наши решения могут влиять эмоции, на ИИ можно положиться в принятии точных и непредвзятых решений.

Преимущества искусственного интеллекта (ИИ) невероятны. Что может предложить нам эта технология, так это возможность развиваться и продвигаться вперед в истории искусственного интеллекта. Вот основные преимущества ИИ.

- Выполнение задачи быстрее, чем человек
- Напряженная и сложная работа выполняется легко
- Сложные задачи выполняются за короткое время
- Различные функции могут быть выполнены одновременно
- Коэффициент успешности высокий
- Меньше ошибок в задачах и дефектов
- Более высокая эффективность за короткое время
- Меньше места и габаритов
- Расчет долгосрочных и сложных ситуаций
- Открытие неизведанных объектов, таких как структура ДНК

Персонализированное обучение: образовательные платформы на базе искусственного интеллекта могут адаптироваться к индивидуальным потребностям и стилю обучения учащихся, обеспечивая персонализированный опыт обучения. Такой индивидуальный подход повышает вовлеченность, понимание и удержание учащихся.

Интеллектуальное обучение: искусственный интеллект может выступать в роли виртуального репетитора, обеспечивая обратную связь в режиме реального времени, отвечая на вопросы и предлагая дополнительные ресурсы для учащихся. Такая мгновенная поддержка помогает учащимся преодолевать трудности и способствует самостоятельному обучению.

Автоматизация административных задач: Искусственный интеллект может упростить административные задачи, такие как выставление оценок, составление расписания и организация учебных материалов. Такая автоматизация освобождает ценное время преподавателей, позволяя им сосредоточиться на учебной деятельности и взаимодействии с учащимися.

Аналитика на основе данных: Алгоритмы искусственного интеллекта могут анализировать огромные объемы образовательных данных, предоставляя ценную информацию об успеваемости учащихся, моделях обучения и областях, требующих улучшения. Учителя могут использовать эти данные для принятия обоснованных учебных решений и соответствующим образом адаптировать свои стратегии преподавания

Хотя искусственный интеллект (ИИ) обладает огромным потенциалом, он также вызывает опасения по поводу возможных негативных последствий. Одной из проблем является влияние на занятость. ИИ продолжает развиваться, и существуют обоснованные опасения по поводу сокращения рабочих мест и потенциальной потери средств к существованию, особенно в отраслях, где автоматизация может заменить человеческий труд. Кроме того, ИИ связан с этическими проблемами, такими как конфиденциальность и безопасность данных. Сбор и использование огромных объемов персональных данных системами искусственного интеллекта вызывает вопросы о нарушениях конфиденциальности и потенциальном неправомерном

использовании. Более того, существует риск предвзятого принятия решений, если алгоритмы ИИ обучены на основе необъективных данных или если они непреднамеренно закрепляют и усиливают существующие в обществе предубеждения. Это может привести к несправедливым результатам и дискриминации. Кроме того, зависимость от систем искусственного интеллекта может привести к чрезмерной зависимости и недостатку человеческого суждения, особенно в важных областях принятия решений, где человеческий подход и тонкое понимание нюансов имеют решающее значение. Важно справиться с этими вызовами и обеспечить ответственную разработку и внедрение ИИ с надлежащими мерами предосторожности и нормативными актами, чтобы смягчить потенциальные негативные последствия и обеспечить максимизацию его преимуществ при минимизации потенциального вреда.

Недостатки ИИ в обучении:

Отсутствие взаимодействия с людьми: Хотя ИИ может предложить опыт обучения, ему не хватает человеческого контакта и эмоциональной связи, которые поддерживают отношения между учителем и учеником. Некоторые учащиеся могут испытывать трудности с отсутствием взаимодействия с людьми, что приводит к ощущению изоляции или отстраненности.

Этические аспекты: Использование ИИ поднимает этические вопросы, касающиеся конфиденциальности данных, безопасности и предвзятости. Важно обеспечить, чтобы алгоритмы ИИ были прозрачными, справедливыми и не увековечивали какие-либо формы дискриминации или неравенства.

Технические ограничения: системы искусственного интеллекта могут сталкиваться с техническими сбоями или ограничениями, нарушающими процесс обучения. Использование искусственного интеллекта в качестве единственного средства обучения может создавать проблемы при возникновении технических проблем, оставляя учащихся без немедленных альтернатив.

Вот некоторые из основных проблем и недостатков искусственного интеллекта (ИИ) в нашей повседневной жизни:

- Иногда это может быть использовано не по назначению, что приводит к массовым разрушениям.
- Иногда программа может выполняться вопреки приказу.
- Это влияет на рабочие места людей и усугубляет проблемы безработицы.
- Креативность зависит от программиста, и в ней не хватает человеческого подхода.
- Молодое поколение становится ленивым, и ему требуется много времени и денег. Технологическая зависимость возросла.

ИИ предлагает ряд методов, которые можно эффективно внедрить в класс, улучшая учебный опыт учащихся и поддерживая учителей в их учебной практике. Интеллектуальные системы обучения, основанные на искусственном интеллекте, могут обеспечить персонализированную обратную связь, адаптивные пути обучения и интерактивные занятия, адаптированные к потребностям каждого учащегося, способствуя индивидуальному и самостоятельному обучению. Чат-боты на базе искусственного интеллекта и виртуальные помощники могут помочь учащимся, отвечая на их вопросы, предоставляя дополнительные ресурсы и предлагая поддержку во внеурочное время. Возможности обработки естественного языка позволяют ИИ анализировать и оценивать ответы учащихся, помогая автоматизировать выставление оценок и обеспечивая

своевременную обратную связь. ИИ также может способствовать совместному обучению, обеспечивая сотрудничество и общение между учащимися в режиме реального времени, независимо от их физического местонахождения. Более того, анализ данных и анализ обучения на основе искусственного интеллекта могут предоставить ценную информацию об успеваемости учащихся, моделях обучения и областях, в которых можно добиться улучшения, что позволяет учителям отслеживать прогресс и соответствующим образом корректировать свои стратегии обучения. Используя эти методы искусственного интеллекта, классы могут стать более динамичными, увлекательными и персонализированными, создавая благоприятную среду обучения для всех учащихся.

Заключение

В заключение отметим, что интеграция искусственного интеллекта (ИИ) в образование обладает огромным потенциалом для преобразования учебного процесса и приносит пользу как учащимся, так и преподавателям. Используя методы искусственного интеллекта, такие как интеллектуальные системы обучения, виртуальные ассистенты и аналитика данных, классы могут стать персонализированной, привлекательной и эффективной учебной средой. Учащиеся получают персонализированные пути обучения, адаптивную обратную связь и возможности для совместной работы, что приводит к улучшению понимания, развитию навыков критического мышления и самостоятельному обучению. Одновременно учителя могут автоматизировать административные задачи, получать информацию об успеваемости учащихся на основе данных и внедрять индивидуальные стратегии обучения. Интеграция ИИ в образование позволяет учащимся стать независимыми и заинтересованными учениками, а преподавателям - оптимизировать свои методы преподавания и создавать инклюзивную среду обучения. Поскольку ИИ продолжает развиваться, жизненно важно обеспечить ответственное внедрение, устранить возможные предубеждения и поддерживать баланс между ИИ и человеческими ресурсами взаимодействие в образовательном процессе. Используя преобразующую силу искусственного интеллекта, мы можем открыть новые возможности, улучшить результаты обучения и сформировать будущее, в котором образование будет доступным, эффективным и адаптированным к уникальным потребностям каждого учащегося.

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ТЕХНОЛОГИЯЛАРДЫ БІЛІМ БЕРУДЕ ИНТЕГРАЦИЯЛАУ. ҰЛТТЫҚ ҚҰНДЫЛЫҚТАРҒА НЕГІЗДЕЛГЕН ФИЗИКА ПӘНІНЕ АРНАЛҒАН ЭЛЕКТРОНДЫ КІТАПША

Аннотация. Бұл мақалада ұлттық құндылықтарды технологиямен ұштастырып, физика пәнімен кіріктіре отырып, оқушылардың қызығушылығын арттыру және технологияны физикалық білімге біріктірудің трансформациялық әлеуеті қарастырылады.

Кілт сөздер: Физика, ұлттық құндылық, технологияны интеграциялау, электронды кітапша.

Зерттеу мақсаты мен өзектілігі: Ұлттық құндылықтарымызды басшылыққа ала отырып, технологияларды физика пәніне интеграциялау екі мақсатқа қызмет етеді: оқыту нәтижелерін жақсарту және тез өзгеріп жатқан әлемде мәдени бірегейлікті сақтау және дамыту.

Кіріспе

Үнемі өзгеріп отыратын білім беру әлемінде «технология» оқыту сапасын жақсартудың жаңа мүмкіндіктерін ұсына отырып, инновацияның шамшырағы ретінде қызмет етеді. Бұл өзгеріс көптеген салаларда білім беру саласындағыдай айқын көрінбейді. Оқытушылар күрделі ұғымдарды жеткізуге және оқушылардың қызығушылығын оятуға ұмтылып, көптеген жұмыстарды атқаратындықтан, технологияны біріктіру күшті нақты мақсатқа айналады. Бұл мақалада, біз жұмыс жасап жатқан электронды кітабымызға енгізілген ұлттық құндылықтар мен принциптер физика пәнін қалай толықтыратынына және күшейтетініне назар аудара отырып, технологияның физика пәнінде революциялық жетілдірудегі рөлін тереңірек қарастырдық.

Физиканы оқытудағы технологияның рөлі. Дәстүрлі түрде физиканы оқыту көптеген уақыт бойы оқулықтар мен дәрістерге сүйенді, нәтижесінде студенттер абстрактілі теориялар мен теңдеулерге жиі тап болды. Дегенмен, технологияның динамикалық, интерактивті оқу тәжірибесін ұсыну арқылы бұл алшақтықты жоюға мүмкіндіктерге жол ашылды. Қазіргі таңда модельдеу, виртуалды зертханалар және мультимедиялық презентациялар арқылы студенттер күрделі құбылыстарды елестете алады, эксперименттер жүргізе алады және бұрын елестету мүмкін емес тәсілдермен ғаламның айла-амалдарын зерттей алады [2]. Толықтырылған шындық (AR) және Виртуалды шындық (VR) қосымшалары оқушыларды алыс галактикаларға немесе

микроскопиялық әлемдерге саусақпен немесе гарнитураны басу арқылы жеткізудің қызықты тәжірибесін ұсынады [1]. Онлайн ынтымақтастық платформалары студенттер мен оқушылар арасында қауымдастық пен ынтымақтастық сезімін нығайту арқылы өзара оқыту мен мәселелерді шешуді жеңілдетеді.

Ұлттық құндылықтарға негізделген электронды кітапша. 2023-2024 оқу жылдарында физика пәні мұғалімдері біріге отырып, ұлттық құндылықтарға негізделген физика пәнінен оқушының қызығушылығын арттыратын, берілген теориялық, практикалық білімді есте сақтауға айтарлықтай көмек беретін кітапшаны жазып шығардық (1-сурет). Физика пәнінен электронды кітапшыға енгізілген ұлттық құндылықтар мен принциптер: білім беру революциясының негізі деп санайтын біздің физика пәніне арналып жазылған электронды кітапшамыз теориялар мен теңдеулер жинағы ғана емес; бұл ғасырлар бойы қазақ мәдениетін қалыптастырған тұрақты құндылықтар мен принциптердің көрінісі. Ата-бабаларымыздың даналығынан шабыт ала отырып, электронды кітап өзінің негізгі ілімдеріне бірлік, тұрақтылық және ұлттық дәстүрлерімізді терең құрметтеу сияқты құндылықтарды қосады. Бұл құндылықтар ғаламды және ондағы біздің орнымызды тереңірек түсінуге жол ашатын бағыттаушы шамдар ретінде қызмет етеді.

1-сурет. Ұлттық құндылықтарға негізделген физика пәнінен электронды кітапша

Бұл электронды кітапша оқыту нәтижелерін жақсартумен қатар, қазақтардың ұлттық құндылықтарына негізделген технологияларды интеграциялау: жаһанданған әлемде мәдени бірегейлікті сақтау және дамыту сияқты кеңірек мақсатқа қызмет етеді. Біздің жасап жатқан бұл жұмыс, тек Қазақстанда ғана емес, ол бүкіл әлем бойынша өзекті мәселе болып саналады. Себебі әлем-бұл әртүрлі мәдениеттердің тоғысқан мозайкасы, олардың әрқайсысының өзіндік ерекше құндылықтары, нанымдары мен дәстүрлері бар. Білім беру материалдарын мәдени маңызды мазмұнмен толтыра отырып, оқытушылар әртүрлі ортадағы оқушылармен резонанс тудыратын инклюзивті оқу ортасын құра алады.

Зерттеу нәтижесі

Мүмкіндіктерді кеңейту және дағдыларды дамыту: технологияны біліммен интеграциялау оқушыларға 21 ғасырда білім бағытында табысқа жету үшін қажетті құнды дағдылар мен құзыреттерді берді. Сонымен қатар, мәдени маңызы бар мазмұнмен танысу оқушыларға өздерінің мұраларын қабылдауға және қоғамға оң үлес қосуға мүмкіндік бере отырып, өзіндік және өзіне деген сенімділік сезімін қалыптастырды. Нәтижесінде, оқушылар мәдени жағынан байытылды,

сонымен қатар өзара байланысты әлемде өркендеу үшін қажетті дағдылар мен құндылықтарға ие болды.

Пайдаланылған әдебиеттер тізімі

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ХИМИЯ ПӘНІНДЕ «СУДЫ ТАЗАЛАУ» ТАҚЫРЫБЫНДА САНДЫҚ ЗЕРТХАНАНЫ ҚОЛДАНУ

Аңдатпа. Мақалада STEM білім беру Қазақстан Республикасының жаңартылған білім беру міндеттерінің бірі ретінде қарастырылады. STEM-технологиясын Химия сабағында қолданудың артықшылықтары көрсетіледі. Зерттеу мақсаты: №136 жалпы орта білім беретін мектебінде және А.Байтұрсынов атындағы №50 мектеп-гимназиясында оқитын 8 сынып оқушыларының химия сабағында, «Суды тазалау» тақырыбында STEM-технологиясын интеграциялау негізінде сандық зертхананы қолдану арқылы білім алушылардың қызығушылықтарын арттыру және жобалық жұмысқа қатыстыру. Күтілетін нәтижелер: білім алушылар су сапасының табиғи көрсеткіштерін таниды, ажырата біледі, су сынамаларының сипаттамаларын, ауыз суды жабдықтау үшін қойылатын талаптарды анықтайды. Оқушылар сынама ретінде алынған ластанған судың құрамын сандық лабораториялық құралдың сенсорлары көмегімен анықтап, фильтр құрастырып, ластанған суды фильтрден өткізіп, тазартылған судың құрамын салыстыру жұмыстарын жасайды. Сонымен қатар, зертханалық жұмыс барысында сандық құрал-жабдықтарды қолданып, өз беттерімен зертханалық жұмыс және жобалық жұмыс жүргізуге дағдыланады

Түйінді сөздер: STEM білім беру, STEM-технология, сандық зертхана, су сапасы.

ҚР білім беруді дамыту стратегиясы білім интеграциясына және STEM білім беру рөлін арттыруға бағытталған мектептегі білім беру жүйесінің жаңа бағдарларын белгілейді. ҚР Үкіметінің 2021 жылғы 21 қазандағы №726 «Сапалы білім беру «Білімді ұлт» ұлттық жобасын бекіту туралы» қаулысында 2025 жылға қарай негізгі және жалпы білім беретін мектептерді ыңғайлы, қауіпсіз және заманауи білім беру ортасын құру үшін физика, химия, биология, STEM пәндері кабинеттерімен және жабдықтарымен қамтамасыз ету көзделген[1].

STEM (science, technology, engineering and mathematics) - оқытудың біріктірілген тәсілі. Яғни, бұл тәсіл аясында академиялық ғылыми-техникалық тұжырымдамалар шынайы өмір контексінде зерттеледі. STEM-білім беру оқуды және мансапты қосатын көпір болып табылады. Оның тұжырымдамасы балаларды технологиялық тұрғыдан дамыған әлемге дайындайды.

Келешектің мамандарына жан-жақты дайындық пен жаратылыстану ғылымдары, инженерия, технологиялар мен математиканың әр түрлі білім беру салаларынан алынған білім керек [2].

STEM-білім берудің кілттік мақсаты – оқушылардың білу және істей алу қабілеттерін өнертапқыш шешімдер, зерттеушілік қызметтер және тәжірибелік форматтарда көрсету [3]. STEM-білім беру – инженерлік шығармашылық пен математика, жаратылыстану ғылымдары мен технологиялардың кіріктірілуі негізінде жоба және пәнаралық амалдарды байланыстыратын жаңаша ойлау және жаңа технологияларға бағытталған ғылымдардың бірігуі. STEM технологияларын қолданған кезде шешім табу қабілеті дамиды, мәселелер және ақпаратпен жұмыс істеуді үйренеді. STEM технологиясы нақты жауаптар берілмейді, оларды өзіңіз табуыңыз керек. Бұл оқушыларға өз тәжірибесіне сүйене отырып, тұжырымдарды нақтылау, тәжірибеде алынған білім қолдану, проблемаға өзіндік немесе топтық көзқарас ұсынуға мүмкіндік береді [4].

Мұғалімнің міндеті-оқушыдан оқу процесіне белсенді қатысушы жасау. Оқушы ақпаратты тек пәнге қызығушылық танытқан кезде өз іс-әрекетінде ғана игере алады. Сондықтан мұғалім ақпарат берушінің рөлін ұмытып кетуі керек, ол оқушының іс-әрекетін ұйымдастырушы рөлін атқаруы керек, мұғалім тәлімгер, ментор және оқу мен даму болатын ортаны ұйымдастыратын фасилитатор болуы керек [5].

Қазіргі уақытта білім беру саласында STEM технологияларының элементтерін интеграциялау арқылы білім беру сапасын көтеру көзделіп отыр. Қытай философы Конфуцийдың былай дейді: «Естігенімді – ұмытамын, көргенімді – есте сақтаймын, өзім істегенімді – меңгеремін». Демек, оқушылар білім беру процесі кезінде игерген білімдерін бекіту мақсатында практикалық жұмысқа белсенді атсалысу арқылы білім деңгейін шыңдары сөзсіз. Осы тұста STEM-технологиясының білім беру процесінде қолдану өзінің артықшылықтарын көрсетеді.

Біз күнделікті кездесетін су өте таза суға ұқсамайды және оның табиғи сипаттамалары бар, олардың өзгеруі тірі организмдердің өмірі мен қызметіне жағымсыз салдарға әкелуі мүмкін. Сумен жабдықтау суға ең қатаң талаптар қояды. Сапа көрсеткіштерінің үлкен саны бар табиғи суларды әртүрлі критерийлер бойынша жіктеуге болады, бұл оларды әртүрлі тұтынушыларға пайдалануға ұсынуға мүмкіндік береді. Сумен жабдықтау көзін сипаттау үшін сіз суды шаруашылық және ауыз су мақсаттары үшін пайдалану мүмкіндігі туралы бағаланатын әртүрлі көрсеткіштердің жиынтығын білуіңіз керек. Жер үсті суларының әр түрлі белгілері бойынша ұсынылған жіктелімдерін қарастыру барысында, мамандардың пікірінше, бірқатар компоненттерді ескере отырып, кешенді жіктеу жер үсті суларының сапасын ең жақсы интегралды бағалау болып табылатындығын атап өткен жөн (Манчак Х. және т. б. 1982), (1-кесте).

Жалпы зерттеу барысында су сапасының келесідей көрсеткіштері бар:

- *Физикалық*: температура, түсі, иісі, дәмі.
- *Химиялық*: ионды құрамы, pH ортасы, ерітілген газдардың құрамында болуы.
- *Биологиялық*: коли-индек, e.coli бактерияларының саны.

Жер үсті суларының сапа кластары

Көрсеткіш	**Өте таза**	**Таза**	**Өте аз ластанған**	**Аздап ластанған**	**Қатты ластанған**	**Өте қатты ластанған**
Температура, град. С	20	25	25	30	30	30
pH	6,5-7,5	6,1-6,4 7,6-7,9	5,9-6,0 8,0-8,1	5,7-5,8 8,2-8,3	4,0-5,2 8,8-9,5	<4.0 >9.5
Хлоридтер, мг/дм3	50	150	200	300	500	500

Калий ионы, мг/дм3	50	150	200	300	500	500
Аммиак, мг/дм3	0, 1	0, 2	0, 5	2, 0	5, 0	5, 0
ТТР	2	4	8	15	25	25

Химия пәнінде 8-сыныптардың оқу бағдарламасына сай STEM-технологиясын қолдану арқылы «Су» тарауындағы тақырыптарында зерттеу жұмыстары жүргізілді. «Суды тазалау» лабораториялық жұмысын жүргізу кезінде судың қасиеттерін және ластанған суды тазартқан соң су сапасының көрсеткіштерін анықтау мақсатында ReLab.lite программалық жүйесі және сенсорлары қолданылды (1а-сурет).

ReLab.lite программалық жүйесі – мұғалімдерге арналған әмбебап цифрлы зертханалық құрал болып табылады, негізгі қызметі сенсорларының көмегімен белгілі бір химиялық қосылыстың құрамын анықтау (1ә-сурет). Бұл программалық жүйе өзіндік артықшылықтарға ие: дайын жиынтықтар әдістемелік ұсыныстармен бірге жеткізіледі; зертханалық жұмыстардың сипаттамасы берілген; жеке зертханалық жұмыстарды әзірлеу мүмкіндігі; аппараттық және бағдарламалық жасақтаманы үйрену оңай; өлшеулерді жылдам бастау сабақ уақытын үнемдейді [6].

а)


ә)

1а және ә суреттер. ReLab.lite программалық жүйесі

Зерттеу жұмысына Шымкент қаласы №136 жалпы орта білім беретін мектебінің және А.Байтұрсынов атындағы №50 мектеп-гимназиясының 8-сынып оқушылары қатысты. Ең алдымен оқушылар өз қолдарымен ластанған суды тазартатын фильтр құрастырды, фильтр құрамына кіретін тазартушы заттарды келесідей қасиеттеріне қарай жіктеп қолданды (2-кесте).

Фильтр құрамы

Фильтр құрамы	Атқаратын қызметі	Фото
Қиыршық тастар	қиыршық тас немесе ұсақ тастар жапырақтар немесе жәндіктер сияқты үлкен шөгінділерді сүзу үшін қолданылады.	
Құм (кварц)	суспензияны, сондай-ақ қалқымалы және батып бара жатқан бөлшектерді кетіру үшін қолданылады. Бөлшектер сіңіру немесе физикалық инкапсуляция арқылы жойылады.	
Белсендірілген көмір	химиялық сіңіру арқылы ластаушы заттар мен қоспаларды жояды. Органикалық қосылыстар адсорбция әдісімен алынады және сақталады. Хлорды жоймайды, бірақ белсендірілген көмірде сүзілгеннен кейін хлор мөлшері айтарлықтай азаяды және белсенділігі төмендейді.	

Жоғарыда көрсетілген қосылыстар негізінде оқушылар өз беттерінше фильтр құрастырды (2-сурет). Ластанған су Шымкент қаласы «Қайнар бұлақ» көлінен алынып, латсанған судың құрамы анықталынып, фильтрация арқылы тазартылды.

2-сурет. Қолдан жасалған фильтр

Ластанған су фильтр арқылы тазартылғаннан кейін оқушылар ең алдымен физикалық қасиеттерін салыстырды. Нәтижесінде, температурасы 25°С, иісі және түсі салыстырмалы түрде жойылып, тазартылған су мөлдірленіп, жағымсыз иістен тазарғандығын анықтады (3-сурет). Сонымен қатар, салыстырылған екі судың pH-көрсеткіштері салыстырылды (4а, ә-суреттер). Ластанған судың pH-метрі – 7,62, ал тазартылған судың pH-метр көрсеткіші – 7,50-ге тең болды.

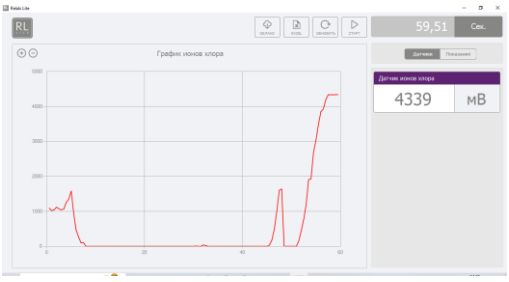
3-сурет. Лас және тазартылған су

а)

ә)

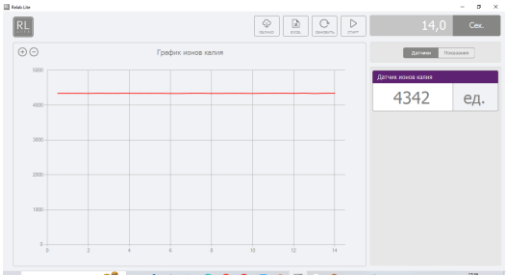
4-сурет. а- лас судың pH-метрі және ә- тазартылған судың pH-метрі

Содан кейін ReLab.lite бағдарламалық жүйесі арқылы 1-кесте бойынша мәліметтерге негізделді. Атап айтсақ, су құрамындағы хлорид ионы (Cl^-) (5-сурет), калий ионы (K^+) (6-сурет), құрамындағы аммиак және аммоний тұздары (7-сурет), тотығу-тотықсыздаену реакцияға қатысу көрсеткіші алынды (8-сурет). Яғни, ластанған және тазартылған сулардың арасындағы айырмашылығы көрсетіліп, талданып, қорытынды жасалынды. ReLab.lite бағдарламалық жүйесі арқылы алынған мәліметтер график түрінде берілді.

а)


ә)

5-сурет. а- лас судың және тазартылған судың Cl^- ионы көрсеткіші



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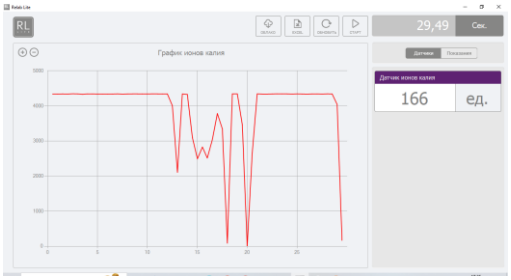
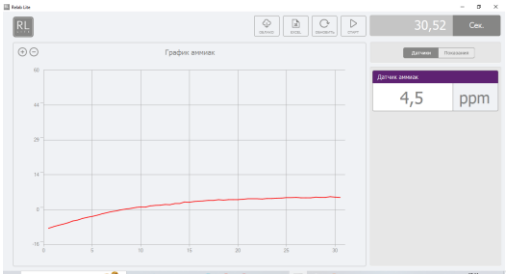


ә)

6-сурет. а- лас судың және тазартылған судың K^+ ионы көрсеткіші



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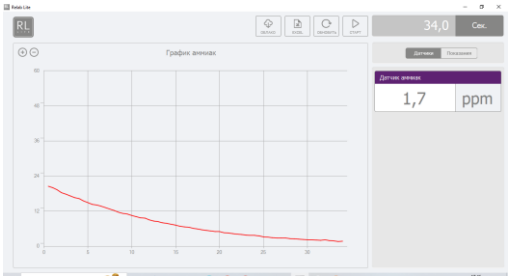
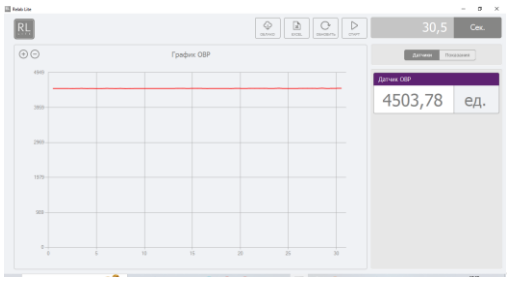


ә)

7-сурет. а- лас судың және тазартылған судың аммиак мөлшері



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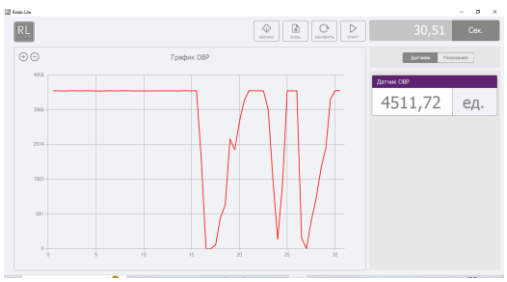

ә)

8-сурет. а- лас судың және тазартылған судың ТТР көрсеткіші

Білім алушылар алынған мәліметтерді өзара талқылап, суды тазартудың әдістері және суды сақтау, су экологиясы жайында проблемалық сұрақтар қойып, нәтижесін анықтап, топ ішінде талдау жұмыстарын жүргізді.

Қорытынды

Қорытындылай келе, STEM-технологиясының негізінде оқушыларға судың табиғи сапасы жайындағы ақпараттар толық анықталынып, судың экологиясы жайында көзқарасы және заманауи платформамен жұмыс жасау дағдысы қалыптастырылды. Оқушыларға суды тазартудың әдістерін, фильтр құрамы таныстырылды. Алынған ақпараттардың негізінде білім алушылар өз

қолдарынан фильтр құрастырды. Фильтрация нәтижесін салыстыру мақсатында ReLab.lite бағдарламалық жүйесі пайдаланылып, алынған ақпараттар талқыланды.

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ЭКСПЕРИМЕНТАЛЬНАЯ ЛАБОРАТОРНАЯ ПЛАТА STEM LOGIC GATES В ИЗУЧЕНИИ ТЕМЫ ЛОГИЧЕСКИЕ ОСНОВЫ КОМПЬЮТЕРА В ШКОЛЕ

Аннотация. Предметом исследования является подход в обучении логических основ работы компьютера. Описаны основные темы, изучаемые в курсе информатики в школе. В статье рассматривается изучение цифровых схем через использование технологии Case study по теме логические основы компьютера в рамках курса информатики в школе. Выявляются особенности выбора технологии раскрытия рассматриваемой в статье темы. Приводится сравнительный анализ особенности подхода Case study и использования разработанной авторами данной статьи лабораторной платы при изучении логических оснований компьютера. В результате работы были проанализированы основные способы раскрытия темы логических основ компьютера и планируемая апробация платы в будущем.

Ключевые слова: case study, подход, логика, логические основы компьютера, цифровая схема.

Введение

Министерство Образования Казахстана ставит высокие цели перед собой в повышении качества подготовки кадров, огромное количество педагогов занимаются исследованиями в направлении повышения уровня образования, для этого также проводятся различные курсы и семинары переподготовки. Изучаются и применяются различные методы и формы обучения для

улучшения качества учебного процесса и повышения мотивации учащихся. В современном уроке просто необходимо развивать у учащихся способности анализировать проблемные ситуации, ученику важно обладать навыками анализа и синтеза, чтобы уметь находить неординарные решения. Умение высказывать свою точку зрения, свои мысли, вносить предложения и идеи, умение выслушивать позицию других людей и аргументировать свою, анализировать и оценивать различные жизненные ситуации. А именно развитие этих навыков требует современное сообщество от специалистов нашего времени.

Сделав анализ научно-педагогической литературы коллег ближнего и дальнего зарубежья, была выявлена значимость применения метода кейса в современной системе образования. Технология метода кейса позволяет развить у учащихся языковые компетенции и повышает уровень анализа, синтеза, интерпретации при обсуждении и дискуссии определенной ситуации. Развитие навыков высокого порядка является главной целью педагогов старшей школы, а для этого необходимо уже в основной школе уметь сформировать необходимые умения и подготовить их.

Виневская, А.В. обозначила, что «…Case-study - одна из новых высокоэффективных технологий обучения, подразумевающая работу с проблемными ситуациями на основе фактов из реальной жизни, чего так часто не хватает для понимания ученикам на уроках.» [1], Савельева М. Г., подчеркнула «…что учащимся предлагают осмыслить реальную жизненную ситуацию, описание которой одновременно отражает не только какую-либо практическую проблему, но и актуализирует определенный комплекс знаний, который необходимо усвоить при разрешении данной проблемы [2]. При этом сама проблема не имеет однозначных решений…», Bruner утверждает, что в методе кейса эффективно используется активное обучение, включает в себя самораскрытие, где учитель выступает в качестве посредника. Создает способность к критическому мышлению… Моделирует процесс индуктивного обучения из опыта: он полезен для продвижения обучения на протяжении всей жизни…» [6].

Применяя данный метод кейса на протяжении учебного года, проводился опрос среди учащихся, тема исследования была выбрана не случайно, алгебра логики применяется при создании элементной базы для вычислительных машин, а также важность и актуальность темы алгебра логики можно рассматривать в трех аспектах: метапредметный, социальный и предметный. Хочется отметить, что все три аспекта направлены на формирование умения рассуждать, конструировать логически и обосновать свое решение задачи, что является лучшим способом раскрытия творческих способностей учащихся. Таким образом, изучение данного раздела доказывает интегрирующую роль информатики в предметах естественно-математического направления [3].

Основываясь на предыдущих отзывах учащихся, мы считаем, что одна из проблем, с которыми сталкиваются учащиеся при изучении темы цифровой логики, связана с абстрактным характером теории. Учащиеся знакомятся с рядом цифровых логических элементов (И, ИЛИ, НЕ, И-НЕ, ИЛИ, ИСКЛЮЧАЮЩЕЕ ИЛИ) и с тем, как эти логические элементы объединяются для создания более сложных цифровых логических схем, таких как простое сложение [4]. Существенным препятствием для понимания учащимися работы отдельных логических элементов является то, что невозможно заглянуть внутрь цифрового логического элемента и понять, как он работает. Вместо этого учащийся должен установить связь между поведением

схемы и ее именем и символом. Затем учащиеся используют эти символы для объединения нескольких логических элементов для создания более сложных схем. В настоящее время педагоги используют виртуальные онлайн лаборатории на уроке, для объяснения принципа работы. Преимущество подхода к программе использования онлайн ресурсов при составлении виртуальной цифровой схемы и заключается в том, что учащийся может экспериментировать и тестировать свою схему. Однако опрос среди учащихся показывает, разочарование учащихся в программе рисования, которая считается слишком абстрактной и сложной, когда учащиеся только что изучили концепцию цифровой логики. Разочарование на этой ранней стадии может привести к отвлечению от темы.

Анализ наблюдения на уроке и результаты опроса показали, что использование физических логических блоков может быть полезным при изучении темы алгебра логики. Доступ к физическому устройству может дать ученику менее абстрактную информацию о поведении логического элемента и схемы. Это может помочь уменьшить некоторую неуверенность начинающего ученика [5]. Важно отметить, что каждый учащийся будет иметь возможность индивидуально строить свою логическую схему, что позволит добиться самостоятельного построения индивидуального образовательного маршрута. Используя цифровые логические блоки, учащиеся смогут физически наблюдать результаты решения задач, а не в виде статического письменного текста на странице или графического представления на экране. Они смогут взаимодействовать со схемой и напрямую наблюдать за результатом своего решения. Такой практический подход облегчит экспериментирование, позволит учащимся оценить эффективность решения и поможет в разработке альтернативных решений. Комментарии учащихся, в опросе были сосредоточены на отсутствии «практического практического опыта работы с аппаратным обеспечением», с предложениями включить «более практические вещи с вентилями - использование вентилей и то, как они работают с двоичными данными» и «более кинестетические учебные ресурсы» [4].

Нами был разработан базовый комплект для построения логических цепей. Комплект состоит из трех панелей входов, логических вентилей и выходов. Комплект был изготовлен матричной платы и электронных компонентов, таких как микросхемы логических вентилей. Они были упакованы в бумажную коробку. Были проведены некоторые эксперименты, такие как реализация логических элементов для полусумматора и полного сумматора простой булевой алгебры.

Электронный комплект Stem Logic Gates (см. рисунок 2) позволяет учащимся играть и экспериментировать с физическими логическими вентилями, тем самым позволяя им увидеть, как выход цифровой схемы реагирует на входы.

Для исследования в качестве сравнения онлайн лаборатория Logicly (Рисунок 1) и разработанная нами собственная лабораторная плата (Рисунок 2), эксперимент проходил среди учащихся 7-11 классов.

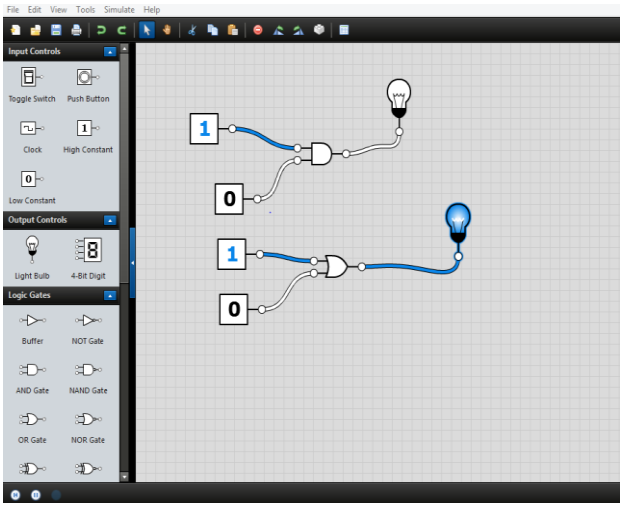

Рисунок 1. Logicly

Рисунок 2. Stem Logic Gates

Используя метод кейсов, учащиеся выполняли задания, составленные с учётом особенностей учебной группы, их интересов и потребностей. При составлении заданий важно использовать структурированные задания позволяющие проверить теоретический и практический уровень знаний в контексте прикладных задач. Развивать навыки обоснования всех этапов решения, грамотного и последовательного построения цепочки рассуждений и преобразований в ходе доказательств [7].

Анализ наблюдения показал повышение уровня вовлеченности в урок, каждый учащийся с особым интересом мог выполнить задания и объяснить поведение логической цепи на выходе, а учащиеся старшей школы могли самостоятельно выполнять задания внешнего суммативного экзамена. Считаю, что внедрение данного метода в обучении темы алгебра логики в общеобразовательных школах поможет при подготовке к Единому Национальному тестированию.

В качестве подтверждения нашего наблюдения также был проведен анализ аналитического отчета внешнего экзамена по данной теме. Трудности встречались по подтемам построения более структурированных и сложных задач. Взяв во внимание решение таких задач, были составлены и апробированы на уроках задания, требующие построения усложненной логической цепи с применением нашей лабораторной платы. По ответам учащихся Внутреннего суммативного оценивания, а особенно, при выполнении структурированных (многоэтапных) заданий, взятых из жизни, учащиеся представляли более подробную информацию по теме вопроса, что означает повышение навыка анализа и синтеза при решении жизненно-ситуационных задач.

Вывод

Мы провели несколько цифровых логических экспериментов с использованием физических логических вентилей (Stem Logic Gates). Цель этих экспериментов — понять влияние использования физической вычислительной среды на взаимодействие учащихся с цифровой логикой. Отзывы учащихся показывают, что использование физических логических блоков помогло лучше понять цифровую логику и цифровые схемы. Обучение учащихся цифровой логике важно для развития у них понимания того, как работает компьютер. В будущей работе мы

планируем расширить количество наборов Stem Logic Gates, доступных каждому учащемуся, и разработать более сложные задания и эксперименты с использованием большего количества логических блоков, также включить набор лабораторных упражнений, чтобы помочь учащимся изучить и понять теорию и практические аспекты цифровых логических элементов. Также планируется адаптировать данные наборы для учащихся общеобразовательных опорных школ, поделиться опытом и обучить учителей информатики сбору таких наборов у себя в школах.

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IMPROVING SECONDARY SCHOOL STUDENT PERFORMANCE IN BIOLOGY CLASSES USING AI

Abstract. The implementation of Artificial Intelligence into teaching biology to secondary school students implies that it will help people learn better and achieve educational goals more effectively.
This study focuses on assessing the impact of AI-driven teaching methods on student motivation and academic performance through qualitative interviews and quantitative surveys with biology teachers, and pre- and post-tests results of students from different schools of Almaty, Kazakhstan. The study found that while there was only a slight improvement in overall academic knowledge, student motivation

significantly increased as a result of the AI-enhanced learning experience. The incorporation of AI technologies stimulated student interest and enthusiasm for biology, fostering a deeper engagement with the subject matter and promoting active participation in learning activities. Overall, this study underscores the importance of integrating innovative technologies like AI into educational practices to create dynamic and engaging learning environments that inspire and empower students to excel in their academic pursuits.

Key words: Artificial Intelligence, AI, Biology, Innovative Teaching, Innovative Technolog

Introduction

The current rapid development of technology, the processes of globalization, and the transition to a digital society certainly concern the field of education. There has never been in history that new reforms, the development of culture and technology did not apprehend the education system. In such a vast world, everything is always interconnected, so new technologies have not bypassed the education system. In the 20th and 21st centuries, the use of innovative technologies entered the daily life of both teachers and students (Yeltunova, I., Nesterov, A., 2021). For example, in 1966, a professor at Stanford University conducted the first experiment on teaching school children through computers. Then various computer systems, programs and platforms began to develop. However, the breakthrough in the widespread use of electronic media in education was during the pandemic. The use of these technologies makes it possible to change the system of the educational process, improve the quality of education, motivate students and immerse them in the educational environment, but of course there are negative sides too. This work is interested in the application of information systems in the field of pedagogy, namely artificial intelligence. "Artificial intelligence" (AI) is a term that was introduced half a century ago, in a summer seminar at Dartmouth College (Hanover, USA) (Ganascia, J., 2018). Artificial intelligence is a field of science and technology that creates intelligent machines and computer programs to perform various tasks that require human intelligence (Bhbosale, S., Pujari, V., & Multani, Z., 2020). It is a system that simulates different functions that a human can perform. A lot of time has not passed with the use of AI in the field of education, but the expected results are promising. For example, facilitating student assessment, promoting personal learning, and completing learning processes online, mixed and offline. Due to the shortage of teachers in the United States, scientists have proposed an option to replace several teacher roles with robots with artificial intelligence (Edwards, B., Cheok, A., 2018). There is a special term "Artificial Intelligence in Education" (AIEd), which is one of the frequently discussed topics among scientists. At the moment, there is a small gap between studying the use of AI in education and its actual implementation in ordinary schools. In the spring of 2023, only 9% of American teachers used artificial intelligence tools, according to the consulting firm Tyton Partners. However, by the autumn of the same year, this figure had increased to 22% (Kelly, S., 2024).

Currently, Kazakhstan ranks 83rd out of 132 countries in the global innovation index. In the ranking of the readiness of states to implement artificial intelligence technologies in 2020, the country ranks 64th out of 172. As part of the digital transformation of public administration and the development of digital technologies, the Ministry of Digital Development, Innovation and Aerospace Industry is developing a concept for the development of artificial intelligence (Bigari, R., 2023).

Problem statement. As the use of AI in other spheres of life shows good results, it means that its use in the educational process can affect the academic performance of students, their motivation and interest in lessons at school. As it is written above, American teachers have already begun to introduce artificial

intelligence into their work, why not introduce this in Kazakhstan? Statistics show that the Republic of Kazakhstan is at the initial stage of AI application. The interest in the influence of AI in the field of education is very high, therefore, this study was charged, which may be an innovation in the education program in Kazakhstan. The correct use of AI can lead to unprecedented results. It became interesting whether it is possible to use AI in the educational process in ordinary schools of the country? Biology is one of the most interesting lessons in school. The integration of artificial intelligence can be much more successful than humanity can imagine. The introduction of AI into the teaching and perception of a biology course can yield significant results, both in the academic part and in improving the interest of students. The purpose of the study is to introduce artificial intelligence in a biology lesson, to understand whether AI affects academic performance and motivation of students.

Research questions. The study will be guided by the following research questions:

- How can AI be utilized to enhance the academic performance of secondary school students in biology classes?
- Is it effective to use AI in biology lessons to improve the students academic performance?
- Are schools in Kazakhstan familiar with using AI in teaching biology?

Hypothesis of the study:

- AI as a tool for enhancement of academic performance can be used for assessment and students' self-work.
- Using AI in biology lessons is effective in many ways.
- Using AI in education is new for most of the Kazakhstani schools.

This work presents the studied literature about artificial intelligence, its application in the educational system, pros and cons. The following parts analyze the methodology of the experiment, its analysis and discussion, concluding with a conclusion on the implementation of AI in biology lesson.

Literature review

AI definition. Nowadays it is difficult to imagine life without the confusion of any innovative systems. Whether it is the field of education, science, medicine, sports, art, etc. any field is connected with the latest digital technologies. Humanity is constantly coming up with something, developing it to improve the quality of life. One example is the emergence of the term artificial intelligence.

What is AI, and how has its existence changed anything on the positive side? Is he smarter than humans? No, says Jean-Gabriel Ganasia, a lecturer in computer science at the Sorbonne University, professor, as well as a researcher at the LIP6 research laboratory (Laboratoire d'Informatique de Paris 6), a full member of the European Association for Artificial Intelligence EurAI (European Association for Artificial Intelligence): this is just a myth inspired by science fiction. Next, we will consider the main stages of the development of this branch of science, the achievements of modern technology and ethical issues that increasingly require attention (Ganascia, J. (2018).

Artificial intelligence (AI) is a branch of science, the property of artificial intelligent systems to perform creative functions that are traditionally considered the prerogative of man (not to be confused with artificial consciousness); the science and technology of creating intelligent machines, especially intelligent computer programs. AI was officially born in 1956 at a summer seminar at Dartmouth College (Hanover, USA), which was organized by four American scientists: John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon. Since then, the term "artificial intelligence", coined, most

likely, with the aim of attracting universal attention, has become so popular that today it is hardly possible to meet a person who has never heard it. Over time, this branch of computer science has developed more and more, and intelligent technologies in the last sixty years have played an important role in changing the face of the world (Ganascia, J. (2018). *The main components of AI*

Artificial intelligence is the result of the synergy of many technological, scientific and industrial achievements of the previous 100 years.

There are many factors that influenced the expansion of AI, but there are several key ones: computing power, Big data (including data analysis algorithms) and innovative machine learning algorithms, especially neural network methods.

One of the main drivers of the rapid development of AI was computer games and gamers, who drove the progress of video cards, which allowed exponentially increasing computing power, which later began to be used for AI projects.

The more data there is, the more accurate the results, so AI could not appear before sufficient computing power, Big Data and a high level of Internet development appeared, but all this needs to be interpreted and processed correctly, i.e. algorithms are needed (Head of Nvidia).

AI methods.

Data analysis

Data Science extracts knowledge, finds patterns in data, and predicts using methods of statistics, econometrics, deep learning, and machine learning.

Artificial Intelligence Training

Main article: Artificial Intelligence Training

Deep Learning AI. For 2023, the following methods are used: backpropagation, Generative Adversarial network (GAN), convolutional neural networks (CNN), recurrent neural networks (RNN), direct propagation networks (FNN), Deep neural networks (Deep Neural Networks) and autoencoders (Head of Nvidia).

Application

Many of the results achieved using AI technologies are superior to humans: in 1997, a computer defeated the then world chess champion, and recently, in 2016, other computers beat the world's best go and poker players. Computers prove or help prove mathematical theorems; knowledge is created automatically, based on machine learning methods and with the help of huge amounts of data, the volume of which is calculated in terabytes (10 to the 12th degree) and even in petabytes (10 to the 15th degree).

Self-learning intelligent systems are widely used in almost all fields, especially in industry, banking, insurance, healthcare and defense. Many routine processes can now be automated, which will transform our professions and eventually eliminate some of them (Head of Nvidia).

Ethical risks

AI does not only involve rational analysis and computer reproduction of most aspects of intelligence – perhaps only with the exception of humor. Machines significantly exceed our cognitive abilities in most areas, which makes us wary of some ethical risks. These are three types of risks: a shortage of work that will be performed by machines instead of people; consequences for human independence and, in particular, for his freedom and security; fears that more "smart" machines will dominate people and cause the death of mankind (Ganascia, J. (2018), (Saghiri et al., 2022).

However, upon closer examination, it becomes obvious that people's jobs are not disappearing, but are being transformed, requiring new skills. Similarly, the independence of the human person and his freedom are not in imminent danger due to the development of AI - provided, however, that we remain vigilant in the face of technology intrusion into privacy (Ganascia, J. (2018), (Saghiri et al., 2022).

And finally, contrary to some claims, machines do not pose an existential risk to humanity, since their autonomy is only technical in nature and in this sense does not correspond to the chains of material causality going from information to decision-making. In addition, machines are not morally independent, and therefore, even if they sometimes confuse and mislead us with their actions, they still do not have their own will and obey the goals that we set for them. (Saghiri et al., 2022).

AI in the education system. The advent of information and digital technologies in our lives simplified a lot of things, reducing the time to complete some tasks in different fields of professions. The development of ICT is improving every year, an example of this is the emergence of a new field in ICT - artificial intelligence. The emergence of AI has increased the effect of work performed in various areas of human life, including in the field of education. The use of AI has led to digital transformations that no one could ever have imagined.

One of the forms of artificial intelligence progress in the field of biology and biological education has led to exceeding expectations in the development of science in these two areas. The application of artificial intelligence in biology and education in biology has opened up new methods and discoveries that can be useful to humanity. Some studies have identified the potential of using artificial intelligence in biology and biology education. The study of various aspects of the literature has led to the identification of various ways to use artificial intelligence. In the field of biology, including the use of artificial intelligence, for the analysis of biological data, genetic research, the study of complex biological phenomena (such as synthetic biology and systems biology), bioinformatics, disease detection and diagnosis. The use of artificial intelligence in various fields of biological sciences, including medicine, agriculture, animal husbandry and industry, contributes to product development and production automation using the Internet of Things (Aripin et al., 2024).

The application of artificial intelligence in the field of education is mainly aimed at assisting in the learning process, creating an intelligent campus and introducing intelligent teaching, teaching and management methods. Image recognition, face analysis, adaptive learning, and other artificial intelligence innovations are being applied in education, initiating change and improving teacher performance (Kuo, 2020) and student learning experience. (Cui, Xue, & Thai, 2019). Moreover, combining artificial intelligence technology and extensive data allows for the collection and in-depth analysis of educational information, which can contribute to improving teaching and improving its quality (Williamson, 2018). Next, a review of the literature on the impact of artificial intelligence on adaptive learning, teacher evaluation, virtual classrooms, intelligent campuses and learning robots will be presented (Huang et al., 2021).

Adaptive learning.

Artificial intelligence contributes to the development of adaptive learning. This approach uses data mining, educational systems, and real-time analytics. The goal of adaptive learning is to integrate testing, learning, memorization and practice into a single system in order to improve the learning process of students (Van Der Vorst & Jelicic, 2019). An adaptive learning system is able to collect data on student behavior. (Goel & Polepeddi, 2016). Currently, many companies offer mature adaptive learning systems

such as DreamBox Learning (Grams, 2018), BYJU'S (Tripathy & Devarapalli, 2020) and IBM Watson Education (Russo-Spena, Mele and Marzullo, 2019). Teachers actively apply various techniques, including classroom systems, to improve the effectiveness of the educational process. One of these methods is ALEKS (Assessment and Learning in Knowledge Spaces), a web-based assessment and learning platform based on artificial intelligence (Huang et al., 2021).

Yilmaz's (2018) study looked at the impact of ALEKS on the academic performance of high school students in mathematics. The results of the study showed that the use of ALEKS has a positive effect on the success of students in mathematics at the end of the school year, according to statistics. However, in a meta-analysis conducted by Fang, Ren, Hu, and Graesser (2019) to evaluate the effectiveness of learning using ALEKS, it was found that ALEKS has the same beneficial effect, but does not exceed traditional classroom teaching, except in certain cases when ALEKS was used for shorter periods, rather than more long-term ones. This research will help teachers using the ALEKS learning system to better inform students about the learning process (Huang et al., 2021).

BYJU'S app is a popular program in India that uses artificial intelligence in teaching, just like ALEKS. BYJU includes online lectures, tasks for mastering topics. In addition, this program uses some animations to explain complex materials and for easy understanding by students. The game control interface allows you to make the learning mode interesting. And also, the BYJU system can offer courses according to the abilities of the students (Kulkarni, Rai, & Kale, 2020). Shruti and Mukherjee (2020) found that the BYJU application has led to changes in education in India by introducing constructive teaching and learning methods. The majority of respondents noted that the application is interactive, convenient and practical. BYJU can also promote deep conceptual understanding in students, and an analysis has been conducted in India on how BYJU promotes deep conceptual understanding (Casanova, 2018). However, the slightly high price may also prevent some students from using it (Huang et al., 2021).

Teaching evaluation.

Student assessment is one of the important parts in the learning process. Without checking and analyzing the results of students, it is difficult to move forward, because when evaluating students, the teacher will be able to understand how much the material has been assimilated, how much the students were able to understand the new topic. Teachers will have to devote a lot of their time and efforts to prepare questions, evaluate students' work, and analyze test papers. However, some AI technologies such as image recognition, forecasting system, computer vision make assessment methods more diverse, the assessment process and the assessment results more accurate (Aripin et al., 2024), (Huang et al., 2021).

Artificial intelligence technology can not only create exam questions (Rahim, Aziz, Rauf and Shamsudin, 2018), but also automatically adjust assignments and test papers (Leeetal.) Correcting homework and tests is a tedious task for teachers. The time cost of correcting home tasks and controlling work leads to the fact that students are tired. Therefore, at the same time, when correcting control papers, errors can occur. Image recognition technology frees teachers from the hard work of correcting homework marks (Li, Cao, & Lu, 2017) and has a low error rate. Artificial intelligence technology is used to correct exam papers and allows you to detect blank or seemingly identical sheets, which saves the teacher time (Koć-Januchta et al., 2020).

Lytek and New Oriental have jointly launched the RealSkill program, which enhances the effectiveness of learning IELTS and TOEFL thanks to intellectual correction and oral practice.Students

can study IELTS and TOEFL using the RealSkill online platform, where the system can perform intellectual assessment, text correction, behavior analysis, intensive lectures, essay writing and study notes to improve exam preparation (Deloitte, 2019).The American Educational Testing Service(ETS) has developed and launched the E-rater (Chen, Fife, Bejar, & Rupp, 2016),a tool for automated assessment of student essays.The e-rater allows you to evaluate the students of the subject structure, grammar, general vocabulary and other aspects.and other aspects of the essay, which not only increases the effectiveness of the evaluators' assessments, but also helps students improve their writing skills.ETS also uses artificial intelligence technology to evaluate spoken English and has developed the SpeechRater engine to help users excel in evaluating spoken English. (Chen et al., 2018), (Huang et al., 2021).

Virtual Classroom

Advances in virtual reality (VR), augmented reality (AR), hearing and perception technologies contribute to changing the educational environment. Ubiquitous information technologies are used to combine physical and virtual space, create virtual classrooms and virtual laboratories (Encalada & Sequera, 2017; Krumm, 2018).

In virtual classrooms, educational situations that are difficult to explain can be simulated using virtual technologies, while natural events and changes that are impossible or difficult to observe in real life can be represented in intelligent classrooms, creating a learning environment adapted to the conditions of students.By presenting educational content in a multidimensional way and mobilizing students' visual, auditory, kinesthetic and other senses for engagement, it can give students a keen sense of reality to help them understand the basic concepts and theories more intuitively and visually, increase students' interest in learning and improve learning efficiency. Hybrid virtual classrooms are a very promising opportunity for course flexibility, as students can come to campus or attend classes at home (Lakhal, Bateman and Bedar, 2017) ((Aripin et al., 2024).), (Huang et al., 2021).

Virtual Simulation Laboratories are virtual recreations of real experimental scenes through 3D modeling using multimedia, simulation and virtual reality technologies that create a working environment for the appropriate software and hardware on a computer, help manage all the connections of traditional experiments or can partially or completely replace them (Wang, Wu, Wang, Chi, &Wang, 2018). By creating highly simulated virtual experimental environments and objects for experimental manipulation, as well as using advanced somatosensory interactive devices for interaction in virtual reality, experimenters can perform various experimental projects as if they were conducted in a real environment (Xu, Ye, Lv, Wu&Gu, 2017). They have no information about damage due to experimental manipulation errors or skipping classical experiments due to experimental conditions. The experimental results obtained turned out to be better than those obtained in a real environment.Virtual experiments are based on a virtual experimental environment (simulation platform) that focuses on the interaction between experimental manipulation and simulation of experimental results (Liu, Valdiviezo-Diaz, Riofrio, Sun and Barba, 2015).Biology (Dirberg, Treusch and Wiegand, 2017), physics (Gunawan, Nisrina, Suranti, Kherayanti and Rahmatia, 2018), chemistry (Herga, Kagran and Dinevski, 2016) and other subjects (Chong and Koh, 2018) can be conducted in a virtual laboratory.The interactive work of the Virtual Modeling Laboratory helps to develop students' practical skills.At the same time, the virtual laboratory equipment allows you to save resources and avoid experimental risks (Orobor & Orobor 2020; Rocca, Rosa, Sassanelli, Fumagalli and Terzi 2020). However, according to Makransky, Terkildsen and

Mayer (2019), scientific learning in virtual reality, despite its motivational properties, can lead to cognitive overload and distraction of students, which can reduce learning outcomes (Huang et al., 2021). Opportunities for using AI in education.

The introduction of AI into the biology teaching process in secondary schools affects their academic performance. If the use of AI would not have any positive result in the learning process, then there would be no point in implementing it. And so, what are the advantages of using AI?

Opportunities for Learners

Traditional teaching sometimes puts students at a disadvantage due to inefficient time spent searching for information, checking facts, or simply learning concepts that are not presented effectively. Chatbots such as "GPT Chat powerful big language model developed by open AI" can significantly reduce learning time by tens or even hundreds of hours with endless access to information (Rahman & Watanobe, 2023).

Perhaps many people have come across the fact that you spend too much time and effort searching for information on a certain topic on Google. If you ask a chatbot, create a step–by-step explanation of this concept in simple words. He will create a step-by-step diagram and explain to you everything you want to know.

Imagine how much easier learning can be when you use GPT chat to present information in ready-made diagrams, without wasting time searching for all the information yourself.

GPT chat can be used as a virtual tutor. For example, you can ask the GPT chat to ask questions about how dopamine works one question at a time. Regardless of whether the answer is correct, it provides an explanation (Rahman & Watanobe, 2023).

This method is effective because it really challenges you to reproduce the information you have just learned, thereby strengthening the connections between your brain and new information.

To use this feature, you can try this hint. You're a biology teacher. Create 10 questions with a choice of answer on the topic of, for example, cellular respiration. There should be one correct answer and three incorrect ones. Let me answer one question at a time before providing the next question. After each of my answers, tell me if it is correct and provide an explanation accordingly. You can also add the query "rate my grade as a percentage".

As a result, bot gives an explanation of the mistakes that were made, as well as evaluates knowledge and suggests what else needs to be learned (Rahman & Watanobe, 2023).

Explanation of scientific terms. The GPT chat can provide analogies to better understand any misunderstandings or questions that students may have. Students can continue to ask any GPT Chat questions until they have mastered the concept or idea well enough.

Opportunities for Teachers

In addition to explaining a new topic to students, to prepare materials for the lesson, teachers have to make up tasks and homework on the topics covered, check the answers of each student, give a grade and sometimes organize extracurricular activities on various topics. Such types of efforts can reduce the effectiveness of preparing the basic material and reduce the time of teacher-student interaction, which is an important part of the learning process. Another value of artificial intelligence in education is that it can reduce the burden on teachers and make them more focused on humanistic care. Below are some examples of using AI to improve the effectiveness of teaching for teachers (Nasution, N. 2023).

1) Lesson planning. There are several types of AI such as “chat GPT”, “lesson plans.ai”, “copilot”, “eduaide.com” to prepare each lesson plan. These AI tools allow you to provide illustrations, event ideas, and exercises on specific topics that will help teachers better educate their students.
Example using an AI to create a lesson plan (eduaide.com) (Nasution, N,. 2023).

“Unit: Cellular Respiration
Grade Level: Underclass (Students Grade 9-10)
Lesson Duration: 45-52 minutes
Instructional Model: 5E Model (Engage, Explore, Explain, Elaborate, Evaluate)
Lesson Outline:
Engage (5 minutes):

- Begin the lesson by asking students to brainstorm and share what they know about energy and how our bodies obtain it.
- Show a short video clip or image related to cellular respiration to pique students' interest and activate prior knowledge.

Explore (10 minutes):

- Divide students into pairs or small groups.
- Provide each group with a set of materials, including a respirometer, test tubes, pipettes, and a small amount of yeast (used as a cellular model).
- Instruct students to design an experiment to investigate the relationship between temperature and the rate of cellular respiration in yeast.
- Encourage students to think critically about the variables they need to control and the data they should collect.

Explain (15 minutes):

- Facilitate a whole-class discussion to share and analyze the results of the experiment.
- Introduce the concept of cellular respiration and its importance in producing energy for cells.
- Explain the different stages of cellular respiration, including glycolysis, the Krebs cycle, and the electron transport chain.
- Use visual aids and real-life examples to help students understand the processes involved.

Elaborate (10 minutes):

- Assign students a task where they have to create a concept map or a flowchart to depict the different stages of cellular respiration.
- Encourage students to include key vocabulary, main processes, and the products of each stage.
- Provide additional resources (books, websites, etc.) for students who need more information or want to explore further.

Evaluate (10-12 minutes):

- Distribute a worksheet or an online quiz to assess students' understanding of cellular respiration.
- The assessment should include questions that require students to apply their knowledge, such as explaining the differences between aerobic and anaerobic respiration or identifying the main products of glycolysis.
- Provide feedback and discuss the answers as a class to address any misconceptions.

Closure (5 minutes):

- Summarize the main points of the lesson, emphasizing the importance of cellular respiration in providing energy for our bodies.
- Ask students to reflect on what they have learned and how it connects to their prior knowledge of energy.
- Encourage students to ask any remaining questions or seek clarification on any concepts they find challenging.

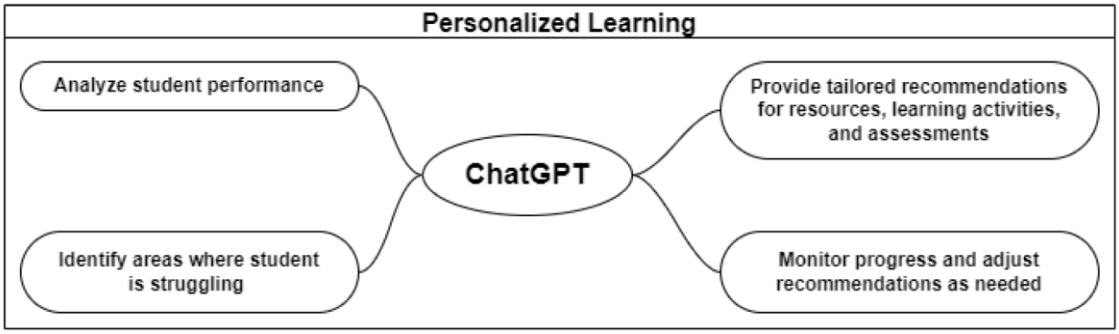
Options for Differentiation:

- Provide additional resources or reading materials for students who need extra support or want to delve deeper into the topic.
- Adapt the experiment for students with different learning needs, such as providing step-by-step instructions or modifying the data collection process.
- Offer alternative assessment options, such as a verbal presentation or a hands-on demonstration, for students who may struggle with written assessments.

Assessment of Learning:

- The worksheet or online quiz provided during the evaluation stage will serve as the assessment of student learning.
- Additionally, informal assessment can be done throughout the lesson through observation and class discussion to gauge students' understanding and engagement."

2) Personalized Learning Support: Teachers can use ChatGPT to provide personalized learning support for students. ChatGPT can offer customized resources and training activities. For example, teachers can use ChatGPT to analyze student performance data and identify areas where students have difficulty with certain concepts or algorithms (Rahman & Watanobe, 2023).



example using chat GPT for personalized learning

3) Task creation. Assignments on the topics covered, home lessons have an important role in the learning process, since with the help of tasks, students can consolidate the material they have passed, teachers can observe how much the topic was clear to the students, how much the material was studied enough. Creating tests, tasks, and other materials is the teacher's responsibility. And sometimes the teacher tends to make mistakes when creating tests and answer options for them. AI for creating tasks will help teachers improve the quality of teaching. Some studies have shown that 79% (out of 272 students) of the students indicated that the questions generated by AI were relevant to the subject of the lesson. 72% of the students reported that the clarity of the AI-generated questions was acceptable. 73% of the students reported that

the accuracy of the AI-generated questions was good. Based on the results of the study, 20 of the 21 questions generated by Chat GPT AI were correct and accurate. AI such as quizbot, twee. com, conker, chat GPT are an example for creating questions, tests for lessons (Nasution, N. 2023).

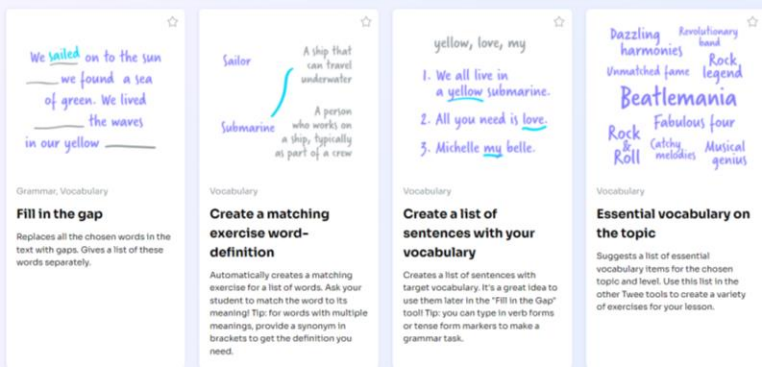


Figure 1. Example of using AI (twee.com) for task generation.

4) Grading and assessment. Evaluating completed work takes a lot of time, effort from teachers and is also a very monotonous job. Some AI such as "Gradescope" saves many teachers' time and improves work efficiency. Grade scope is an artificial intelligence-based grading tool that has been gaining popularity among teachers lately. It is designed to make the assessment of papers, assignments and exams more efficient and easier. The best part is that Gradescope is able to support grading across a wide range of subjects and levels in the natural sciences and humanities. Gradescope has a built-in plagiarism check feature that helps teachers identify unoriginal work without leaving the platform. In addition, Grade scope provides detailed analytics that allows teachers to identify areas for improvement. Grade scope helps you easily manage all your grades, whether online or in class. Save time on grading and get a clear picture of how your students are doing (ClassPoint, 2024).

Challenges of using AI in education.

Every novelty that has entered our lives has a number of drawbacks and negative sides. As mentioned above, the introduction of artificial intelligence into the educational process has a rather positive effect, since AI in education increases the effectiveness of teachers' work, helps students study the material at a sufficient level, reduces time for monotonous tasks of teachers, etc. However, despite what AI is capable of, a person using it may face difficulties, threats and have difficulties with AI. Next, let's look at the difficulties and negative aspects of implementing AI in education.

Ensuring inclusiveness and equality in the use of artificial intelligence in education.

As mentioned above, AI can provide many opportunities in the learning process. However, it can lead to a deepening of existing inequality and division, as the population who are disadvantaged will be excluded from AI-based education.

The result is a new kind of digital divide: the gap in the use of data-based knowledge to justify smart decision-making (Hilbert, 2015).

Equality and inclusivity are core values in the development of artificial intelligence policy in education. Thus, policy makers should ask several questions about implementation and equity when developing their policies. For example, what infrastructural conditions are relevant in developing countries to make possible the use of artificial intelligence in education? What have we learned from previous experience to create sustainable and fair conditions for the realization of digital rights in terms

of Internet access? How can artificial intelligence improve the effectiveness of education provided to disadvantaged groups? How can digital education and artificial intelligence develop much faster in developing countries to reduce the educational gap between the world's rich and poor students? What are the best practices in artificial intelligence for women and girls to reduce gender inequality (UNESCO,2019)?

Recent research has identified obstacles to the introduction of artificial intelligence into education in developing countries. The main ones include 1) availability of ICT hardware, 2) availability of electricity, 3) Reliability of the Internet, 4-) Cost of data transmission, 5) Basic ICT skills of students, 6) Language and 7) Lack of culturally appropriate content (NYE, 2015). Further reviews of the implementation of big data in developing countries show that the lack of basic infrastructure creates a new digital challenge in using data-based knowledge to make informed intelligent decisions (Hilbert, 2015). To eliminate these obstacles, many strategies need to be developed. It is important to start by defining the Internet as a human right and building numerous international alliances to build infrastructure in the poorest sectors of the developing world (Mutoni, 2017) (UNESCO,2019).

The work carried out by the United Nations Broadband Commission is one clear example of this.

The complexity of evaluating responses and texts generated by a chatbot: Like LLM with artificial intelligence, chatbots such as ChatGPT use complex algorithms and statistical models to produce responses and text based on templates extracted from large amounts of text data. The answers and texts generated by Chat GPT become the same as the answer and text that the person generated. This creates a problem for teachers and researchers. It is becoming increasingly difficult for existing plagiarism detection tools to distinguish between texts created by artificial intelligence and humans. As a result, restrictions were imposed on the use of Chat GPT in educational institutions. Cotton et al. introduced several text recognition strategies from LLMS such as Chat GPT, including language inconsistencies, lack of proper citations, factual errors, ambiguity, and poor understanding of context. Further research is needed to develop new technologies (for example, plagiarism detectors based on

artificial intelligence) to ensure the integrity of education and scientific research (Rahman & Watanobe, 2023).

Ethical aspects and possible biases: It is necessary to carefully analyze the ethical consequences and biases associated with the use of Chat GPT in education and research. In most cases, LLMs are highly dependent on training data, and if this data contains bias or anomalies, it can lead to unfair results. For example, if the training data contains bias against certain groups of people or cultures, the model may generate unfair or discriminatory conclusions. Therefore, it is essential to ensure the diversity and balance of training data. Systems such as ChatGPT and other artificial intelligence language models can be used to create false news, incite hatred and other malicious content. This can lead to social upheaval, reputation damage, and even physical harm. In addition, internal mechanisms and processes are not transparent enough for users regarding their functioning. It is also important to ensure that the decision-making processes in these models are transparent to users. Since ChatGPT automatically generates responses without human intervention, it is difficult to determine responsibility for the created content. This makes it more difficult to address ethical issues and bias issues. Generative models such as ChatGPT may require the collection and processing of personal data, which raises concerns about the

confidentiality and security of information. Appropriate measures must be taken to protect personal data from unauthorized access (Rahman & Watanobe, 2023).

Critical thinking and problem solving skills: Simply getting answers from ChatGPT can be an obstacle to developing students' critical thinking and problem-solving skills. Since the Chat GPT can provide almost accurate answers to technical questions from a wide range of topics and correct or partially correct program code based on descriptions of problems, algorithms and task names, etc. As far as we know, there are no such tools that can recognize the code generated by artificial intelligence models, and thus the decision codes generated by artificial intelligence models can be used for academic programming exams and competitions. This poses the problem for educators of how to deal with this new situation (Rahman & Watanobe, 2023), (Huang et al., 2021).

However, there are strategies for determining whether ChatGPT responses and program codes are created. It is important to pay attention to the following features: ChatGPT responses usually do not contain personalization and are general in nature. In addition, program code usually includes syntax and formatting. Consistency checking is also important: ChatGPT responses may lack consistency or logical construction, especially in the case of complex queries. If the answers seem incoherent or meaningless, it may indicate that they were created by ChatGPT or another artificial intelligence model. By comparing the answers created by ChatGPT with the answers created by other language models or real people, we can determine their origin. If the response matches the responses generated by ChatGPT, this may indicate its automatic origin. Using Plagiarism Detection tools: We can also use plagiarism detection tools to determine if the response contains program code copied from somewhere else. This can help identify cases of fraud. In addition, if fraud with program codes is possible, we can ask additional questions to determine the depth of students' understanding of the answer to the question (Huang et al., 2021), (Rahman & Watanobe, 2023).

Methodology

Collecting data

The methodology to collect data in this research work is based on quantitative and qualitative research methods. First, as a quantitative research method, there was a survey questionnaire for students to collect information about their familiarness with AI tools and their expectations from this research as participants:

Questionnaire

1. *Your gender?* Female or Male
2. *Your age?* 12-13; 14-15; 16-17; 18
3. *Your grade?* 7,8,9,10,11
4. *Your school?* Alkiz, BIL, SDL, Kursant, Dostyk
5. *How familiar are you with the concept of Artificial intelligence (AI)?* Very familiar; Somewhat familiar; Not familiar
6. *Do you know the difference between AI powered tools and traditional applications?* Yes; No
7. *Do you use AI powered tools or applications as part of your educational activities?* Yes, frequently; Yes, occasionally; No, never
8. *If you have used any AI tool, what kind of AI tool was it?* ChatGPT; Grammarly; Quizlet; Kahoot; Educaplay; Blooket; Quizizz; Photomath; Canva; Tome.app

9. *For what purpose did you use an AI tool?* To create a presentation; To write an essay; To create questions; To generate pictures; Not for learning
10. *Do you want to use AI in your studying process?* Yes, Maybe, No
11. *At what exact stage of the learning process would you like AI to help you?* To do homework; To solve mathematical problems; To explain topic with simple language
12. *Are you concerned about potential drawbacks associated with the integration of AI in education, such as privacy issues or biased algorithms?* Very concerned; Somewhat concerned; Not concerned at all
13. *What are the potential drawbacks or risks associated with the integration of AI in education in your opinion?* (Open question)

As a qualitative research method, interviews were taken from teachers, also about familiarness and usage, if it is used what kind of Ai powered tools exactly they have used till that day:

Interview

1-How familiar are you with the concept of AI in the context of education?

2-Have you actively used any AI tools or applications in your biology lesson? If yes, please provide examples.

2a- In what purposes did/do you use AI tools?

3-What challenges and opportunities do you see in incorporating AI into biology teaching?

4-Have you observed any changes in student engagement or interest in biology as a result of incorporating AI into your lessons?

5-In your opinion, how important is AI in enhancing the learning experience for biology students?

6-Are there any concerns or preservations you have about the use of AI in biology education, such as ethical considerations or potential drawbacks?

7-To what extent do you see AI being integrated into biology education in the future?

Methods

The general starting point was a test that was taken to determine the average current score in order to compare the starting and final result at the end after the experiment. Most valuable criteria of chosen tools were reliability of tools in explaining the content. Mostly it was a quiz creating strategies by using AI powered tools. For example: using game apps/sites such as joyteka, blooket, kahoot etc to create entertaining quizzes but integrating only AI ChatGPT generated questions or using separate apps that create quizzes and questions by itself using a certain AI tool such as educaplay.

Method 1

Experiment: 8A and 8b. They were given different tasks to accomplish

Observant: 8C. Was taught using traditional methods.

Topic was Reproduction.

Pre-test is a mini quiz that they wrote after passing the topics taught in traditional ways.

Methods: mainly for assessment and during the lesson.

1-Creating anki-flashcards using AI to repeat the past topic. [homework]

2-Using ChatGPT as a search engine during the lesson activity:

Students write the questions they got during the lesson (passing new topic) on 3 question papers (each for each row). Then collect the papers and we together search for the answers using ChatGPT. Then

each student is asked with the questions he wrote and he had to answer using the gained knowledge. [classwork]

3-Generating questions for kahoot and educaplay using AI. [classwork]

4-Generating images using AI (Kandinskiy telegram bot). At first students were given to write an essay on "What will the world without mitosis look like?". The next lesson they were asked to generate an image of what it would look like without mitosis. [Homework]

5-Voicing the video using AI. Students were given to write a song on "Ear structure" using AI or voice videos from youtube. Some students voiced the song-video about ear structure with the voices of famous people using AI.

Method 2

10 "B" grade

15 students, the topic was cell, cell structure.

1. Pre test to check their previous knowledge. Introducing students with different types of AI

2. Students write any questions about topic on paper, then we ask this question from chat gpt

3. Divide them into 4 groups by 3-4 students, and for homework give them task to prepare presentations for given topic. Students use Chat GPT as a source of information, tome and Gemini to make a presentation, Copilot to generate pictures. Then they defend it to other students.

5. By using Chat GPT I generate games related to our topic. They play this game in groups. Post test to compare with pre tests

Method 3

9 "A" grade

20 students, Introduction to Genetics Chapter.

1. *Taking a pre test by summative assessment 1.*
2. *Explaining the base of a topic.*
3. *Using a ChatGPT to create mini questions about topic 3-5 differently created but related questions every lesson.*
4. *Every week one hour of a formative assessment as an AI generated quiz about past two topics, approximately 20-30 questions using bloom taxonomy method (when there are used all levels of reaching the topic: remembering understanding, applying, analyzing, evaluating and creating). That continued probably 1-⅕ months.*
5. *Taking the post test as a summative assessment 2.*

Ethical considerations

Through a process of this research ethical considerations were included. First off, all marks are not personally identifiable information, all grades are named with a letter randomly. We used all data privacy to prevent potential biases and measures were taken to anonymize and secure all data.

In summary, the methods of this study are all based on making questionnaires or answering questions by ChatGPT AI powered tools. And for collecting data there were quantitative and qualitative methods of research.

Analysis and findings

This part presents the analysis of gathered data and the findings on using AI in biology lessons.

Survey results

At the beginning of the experiment we conducted a survey among students from 5 different schools.

121 students participated in the survey.

Grade	7	8	9	10	11
Students number	8	35	17	15	46

Table 1. Results from the survey to question: *Your grade?*

To the question: "How familiar are you with the concept of Artificial intelligence (AI)?" the majority (71%) of respondents answered that they are "Somewhat familiar" with AI. 20, 7% of them answered "Very Familiar", 8,3% of students answered "Not Familiar" with AI. To the question: Do you know the difference between AI powered tools and traditional apllications? 52,1 % of the respondents answered "Yes", 47,9% answered "No". According to results, 70,2% of respondents use AI tools or applications "Occasionally" as part of their educational activities. Only 13,2% use "Frequently" and 16,5% of the respondents "Never" use AI tools or applications in their educational activities.

The most often used AI tools by respondents are Kahoot (80,7%), Quizizz (81%), ChatGPT (54,5%), Quizlet (47,1%), Photomath(45,5%), Canva(40,5%).

51,2% of respondents use AI tools to create a presentation, 31,4% to write an essay, 38,8% to create questions, 7,4% to generate pictures, 18,2% use AI tools not for study. To the question: Do you want to use AI in your studying process? 52,1% answered "Maybe", 38,8% answered "Yes", 9,1% answered "No"

Pre- and post-test results

This part provides information on the Pre test, which was conducted at the beginning of the experiment and the Post test, which was conducted at the end of the experiment.

Dostyq school		Kursant school		Almaty High School for Girls		Syleyman Demirel Lyceum	
Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
65,8%	62,12%	68%	68,75%	63,65%	72,5%	52,55%	69,25%

Table 2: Pre and post tests of students

The Data from Figure ____ shows varying degrees of improvement in post-test scores across the 4 different schools. The experiment at "Dostyq school" was carried out among 11 grade students, at "Kursant school" among 10 grade students, at "Almaty High School for Girls" among 9 grade students and at "Suleyman Demirel Lyceum" among 8 grade students.

Students from "Almaty High School for Girls" and "Suleyman Demirel Lyceum" exhibited a notable increase in their post test scores compared to their pre test scores. "Kursant school" shows minimal change in post test scores compared pre test scores. "Dostyq school" experienced decreases in post test scores compared to pre test scores.

Interview

The interview was conducted with biology teacher of "Dostyq school" (Biology teacher 1) and with biology teacher of "Suleyman Demirel Lyceum"(Biology teacher 2).

To question: How familiar are you with the concept of Artificial Intelligence (AI) in the context of education? Biology teacher 1 answered that he is not familiar with AI in the context of education. Biology teacher 2 answered that she is familiar with AI.

To question: Have you actively used any AI tools or applications in your biology lessons? If yes, please provide examples. Bio1 answered that he uses AI very rarely in educational process, rarely uses the ChatGPT to look for answers to questions that he did not find, and uses "Monica" to generate pictures. Biology teacher 2 uses AI for generating lesson plans and modeling of her lessons, mostly using Chat GPT.

About the importance of using AI in the educational process, Biology teacher 1 answered that AI Should only assist students in the learning process, students can use AI to find out information and maybe generate pictures. Biology teacher 2 answers that AI can help students to achieve some learning goals. They can use AI in virtual labs, classification, provide scientific research and AI can help to find information easily.

To question: What challenges and opportunities do you see in incorporating AI into biology education?

Biology teacher 2 answered that students can face challenges in communication and socialization. Biology teacher 1 thinks that students can stop looking for information on their own from other sources like books.

Discussion

The aim of the paper was to analyze the effectiveness of Artificial Intelligence in improving secondary school students' academic performance in biology lessons using qualitative and quantitative methods. The results clearly showed that artificial intelligence minorly contributed to the enhancement of students' academic performance.

This section discusses and interprets the obtained results, as well as compares them to the already mentioned researches in the literature review.

5.1-The methods of AI usage for enhancement of students' academic performance

The results of the pre- and post-test examinations showed that using AI for assessment and homework completion were the best ways to improve the academic performance of the students. Increase of 8% and 16% of the students' performance in the test identifies that the methods they used to acquire the topic was effective. They were taught mostly by using chat bots such as ChatGPT. Students had to find the answers to their numerous questions using the chat bot. Furthermore, homeworks that students mostly avoid to do was given in a more creative and funny way using AI. For example, create flashcards using AI instead of just reading the topic; voicing the video related to the topic with the voices of famous people; generating images on the questions that make you think, such as "What world would look like without mitosis?". These methods not only engaged students but also made their study different and attractive.

Another aspect that was modified by using AI was assessment. Quizzes for formative and summative assessments were done by the help of artificial intelligence tools. This process definitely made teachers' work easier. Teachers that do not spend their time on creating and checking the quizzes,

can spend it on preparation of effective activities for the class. Such a teacher can make more students learn as he or she will spend the energy in that way.

5.2-Effectiveness of using AI to improve students academic performance

Students from 4 different schools showed different outcomes. Overall, two of the schools participating in the experiment showed a significant increase in the lesson achievements. This can be due to the different factors. One of them is that schools of “Bilim-Innovation” are known to use modern techniques and methods in teaching to develop 21st century skills of students. Therefore, using AI during the lessons, such as ChatGPT, showed a significant effect on students. The other two schools are focused on preparing students for the UNT (Unified National Test). Using AI in these schools didn’t show much effectiveness. This pattern can be seen because of the different methods of teaching and objectives of the lessons that teachers have. Students in such schools are mainly focused on learning the theory by heart and not to develop modern skills or understanding of the new technologies. Adapting AI tools for teaching was complicated.

5.3-According to the interview with teachers it can be stated that most schools are familiar with using AI in their lessons. However,

The use of artificial intelligence (AI) in education in Kazakhstan, particularly in subjects like biology, is continually developing. The country is making notable progress in digital transformation within education, with initiatives such as "Digital Kazakhstan" aimed at improving quality of life through digital technologies, including AI. Moreover, Kazakhstan's Ministry of Education and Science has teamed up with Microsoft to further advance the digital revolution in education. This partnership strives to enhance digital skills and abilities among educators and learners, and to seamlessly integrate digital tools across all levels of the education system, from elementary schools to universities (CEE Multi-Country News Center, 2020). While these are huge efforts by the government, it is still not used and available for the entire Kazakhstan educational community.

Conclusion

The incorporation of AI in biology education has proven to be successful in boosting student involvement and academic achievement. This is accomplished by offering customized learning experiences, adaptable learning settings, and the utilization of AI tools for evaluation and material delivery. The research underscores a number of significant discoveries:

- Improved Academic Results: AI tools have played a significant role in offering tailored and adaptable learning experiences, which meet the unique requirements of students. This individualization has demonstrated potential in enhancing comprehension and recall of biological concepts.
- Enhanced Student Involvement: The implementation of interactive AI technologies, like virtual labs and simulations, has made learning more captivating.
- Improving Teaching Efficiency: AI technology has helped to automate mundane tasks like grading and assessment, giving teachers more time to focus on teaching and engaging with students. This transition has the potential to enhance the overall education experience.
- In addition to the positive results, the study also highlights challenges that must be addressed. These include the necessity for substantial infrastructure improvements, training for educators, and modifying curricula to incorporate AI successfully. Ethical concerns, such as data privacy and potential biases in AI algorithms, also require thorough consideration.

- In the future, integrating AI into education will need strong policy support, ongoing technological advancements, and collaboration among educators, technologists, and policymakers.

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INVESTIGATING METHODS FOR DEVELOPMENT OF STEM CHEMISTRY TEACHER CAREERS

Abstract. This literature review investigates methods utilized in enhancing the skills and knowledge of educators in the fields of science, technology, engineering, and mathematics (STEM). Through a systematic analysis of relevant articles, this study aims to identify innovative methods and effective practices implemented in STEM teacher development programs. The review underscores the need for further research to empirically investigate the efficacy of different approaches and inform the development of impactful professional development initiatives for STEM educators. By exploring new avenues and leveraging evidence-based practices, this study aims to contribute to the advancement of STEM education and the cultivation of a skilled workforce for the future.

Keywords: STEM education, STEM Chemistry teacher, Career development.

Introduction

In the ever-evolving field of education Science, Technology, Engineering, and Mathematics (STEM) have emerged as cornerstones of academic and professional development. STEM education is an approach that integrates these disciplines, improves critical thinking, problem-solving skills, and technological literacy. Its significance lies not only in preparing individuals for specialized careers but also in cultivating a broader set of skills essential for navigating the challenges of the modern world. The objective of this study is to identify prevalent methods utilized in the development of STEM teachers.

Literature review

In numerous countries, the inclination towards selecting a STEM career, particularly in fields like chemistry, is diminishing. Certain studies indicate a decline in the choice of chemistry as a major and profession from high school to higher education. Interestingly, women tend to opt for chemistry more frequently than men at both high school and university levels, while minorities exhibit a greater preference for chemistry in high school but a reduced interest in higher education compared to non-minorities (Avargil, S., Kohen, Z., & Dori, Y. J, 2020). High school serves as a critical period for developing or shaping students' interests and career aspirations, particularly in STEM fields. Effective STEM education in high school emphasizes the relevance of STEM concepts to students' lives and future careers. By showcasing how STEM knowledge and skills are applied in various fields, educators can help students understand the practical significance of these subjects, making them more inclined to

pursue further studies in STEM. Science teachers play a pivotal role in shaping students' academic performance and their decisions to major in STEM fields. Supportive environments, encompassing emotional backing and career guidance, have a constructive relationship with students' expectations for their career outcomes and their belief in their own capabilities. For instance, exposure to science from an early age can shape students' interest in pursuing STEM careers, bolstering their confidence in their abilities and their aspirations for future success.

The significance of fostering individuals' development within the field of chemistry, as well as in STEM disciplines more broadly, is profoundly rooted in the foundation laid during their school education. Research consistently reveals that many professionals in chemistry-related fields attribute their career choice to the captivating experiences they had during their chemistry education at school. These formative educational experiences not only cultivate a fascination for the subject matter but also instill essential skills, knowledge, and a passion for scientific inquiry. Thus, investing in high-quality chemistry education at the school level not only nurtures future scientists and professionals but also serves as a crucial catalyst for innovation and advancement within the broader realm of chemistry and STEM disciplines. Career knowledge entails understanding a specific STEM occupation, such as chemistry, including its prerequisites and anticipated responsibilities. While crucial, STEM career knowledge has not received extensive examination, yet it warrants increased attention. The depth of one's familiarity with STEM careers significantly impacts their inclination towards pursuing a career in STEM fields. In essence, the greater one's awareness of STEM career options, the more likely they are to consider them as viable career paths. Lacking sufficient prior knowledge, students may overlook the possibility of pursuing a career in STEM (Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021).

Teacher training programs in STEM education commonly employ several methodological strategies, including project-based learning, problem-based learning, collaborative learning, ODR approach (observation/discussion/reflection), and design-based learning. Among these strategies, design-based learning emerges as particularly suitable for disciplinary integration. Additionally, two critical competencies emphasized in STEM education teacher training programs are design thinking and computational thinking. These competencies are considered transversal, indicating their relevance across various aspects of the educational process Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L. (2024).

The purpose of this study is to discern and identify various activities or methodologies aimed at fostering the growth and advancement of chemistry teachers` development.

Research question is what specific methods are utilized within development programs aimed at enhancing the skills and knowledge of chemistry teachers?

Methodology

During the review stage, the research utilized Web of Science (WoS) and Scopus, as well as Google Scholar databases employing the search term ([STEM AND development] and [STEM AND Trainings]). These databases were chosen for their reputation in publishing the latest and most relevant literature in the field, as well as their coverage of key journals in science education. The most suitable articles were selected from the filtered results.

Sampling

To achieve the goal, we reviewed 10 scientific works, including scientific journals, articles, and methodological books.

Article name (author, year of publication)	Description
Diep N.H., Hoai V.T.T., Son P.N., Nga P.T., Thuy H.T.P., Duc N.M, 2023	Enhancing the ability to design and orchestrate STEM educational initiatives for natural science educators.
Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021	Selecting Chemistry Across Various Educational and Career Phases: Chemists, Chemical Engineers, and Educators
Avargil, S., Kohen, Z., & Dori, Y. J, 2020	Factors Influencing STEM Bachelor's Degree Attainment and Career Choices: Insights from Sector, Gender, Income, and High School Majoring
Rodríguez-Martín, M., Vergara, D., & Rodríguez-Gonzálvez, P., 2020	Assessing the Efficacy of STEM Teacher Training Programs: An Experimental Study
Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L., 2024	Additional contribution to the previous literatures of training of STEM teachers
Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C.,	Effectiveness of STEM hands-on practical activity during professional development.

Capraro, M. M., & Capraro, R. M., 2022	
Huang, B., Siu-Yung Jong, M., Tu, Y.-F., Hwang, G.-J., Chai, C. S., & Yi-Chao Jiang, M., 2022	Exploring Professional Development Approaches of STEM Teachers
Debeş, G., 2018	Highlighting the significance of STEM seminars for teachers within a developing country

Data collection

I conducted a comprehensive review of STEM teacher development articles from reputable international journals using databases like Scopus and Web of Science. Utilize relevant keywords to identify articles focusing on teacher training methods. Systematically searched databases, screen retrieved articles, reviewed full texts, synthesized findings, assessed quality, and documented key insights for analysis.

Data analysis

The analysis focused on 8 articles pertaining to methods for STEM teacher development. These articles were categorized into four distinct methods: training, bachelor/master degree programs, practical work/hands-on activities, and seminars.

While the analysis provides valuable insights into the methods employed in STEM teacher development, the limited number of articles and potential selection bias are acknowledged as limitations. Further research is warranted to validate the effectiveness of these methods across diverse educational settings.

Result

Article (Author, Year)	Method/Activity name	Frequency	Percentage
Diep N.H., Hoai V.T.T., Son P.N., Nga P.T., Thuy H.T.P., Duc N.M., 2023.	Training	3	37.5 %

Manuel R , Diego V, Pablo R, 2020 Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L. (2024)			
Shwartz, G., Shav-Artza, O., & Dori, Y. J, 2021 Avargil, S., Kohen, Z., & Dori, Y. J, 2020	Graduation with a STEM bachelor's/ master’s degree	2	25 %
Debeş, G., 2018	Seminar	1	12.5 %
Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C., Capraro, M. M., & Capraro, R. M. (2022) Huang, B., Siu-Yung Jong, M., Tu, Y.-F., Hwang, G.-J., Chai, C. S., & Yi-Chao Jiang, M. (2022)	Practical work	2	25 %

Based on the analysis, training emerges as the most prevalent method for STEM teacher development, constituting 37.5% of the articles reviewed. This suggests that training programs for STEM teachers are not only effective but also more commonly utilized in the literature. Conversely, seminars for teachers, such as summer institute programs or short-term seminars, are less explored, with a lower

percentage of inclusion in the reviewed articles. This indicates that such seminar-based approaches may be less common or rare in the development of STEM chemistry teachers.

Conclusion

This analysis underscores the limited exploration and research surrounding the topic of STEM teacher development. The scarcity of literature suggests an unmet need for further investigation to expand the landscape of professional growth opportunities for STEM educators. By delving deeper into this area, future research can uncover innovative strategies and effective practices to enrich the training and support provided to STEM teachers. This will not only enhance the quality of STEM education but also contribute to the cultivation of a more robust and competent workforce in the fields of science, technology, engineering, and mathematics.

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REVIEW ON TEACHER KNOWLEDGE OF CHEMISTRY TEACHERS

Abstract. This research investigates the different aspects of chemistry teacher knowledge. These aspects include subject matter knowledge, pedagogical content knowledge, technological knowledge, assessment knowledge, classroom management knowledge, interpersonal knowledge, and reflective knowledge.

The study found that all of these aspects of knowledge are important for effective chemistry teaching. Teachers who have a deep understanding of chemistry content and pedagogy are more likely to be able to create engaging and effective lesson plans. They are also more likely to be able to use technology effectively to enhance teaching and learning.

Introduction

In recent years, there has been a growing recognition of the critical importance of providing students with a robust education in science, technology, engineering, and mathematics (STEM). This acknowledgment arises from the realization that proficient expertise in these fields is essential for maintaining competitiveness in the global economy and addressing contemporary challenges such as sustainable resource management and technological advancement. Central to this educational imperative is the notion of STEM literacy, which goes beyond mere familiarity with subject matter to encompass a deep understanding of foundational principles and their real-world applications. Scholars and educators alike emphasize the need for students to grasp not only the core concepts within individual STEM disciplines but also their interconnectedness and relevance to everyday life. To achieve these goals, educators are increasingly turning to integrated STEM curricula, which offer students interdisciplinary learning experiences that foster critical thinking, problem-solving skills, and creativity. By breaking down traditional silos between subjects, integrated STEM approaches aim to provide students with a more holistic understanding of complex phenomena and better prepare them for the demands of a rapidly evolving technological landscape. Within this broader framework of STEM education, the role of chemistry teachers is particularly significant. As experts in their field, these educators are tasked with instilling in students a deep appreciation for the principles of chemistry and equipping them with the knowledge and skills needed to excel in this discipline. Understanding the various dimensions of Chemistry Teacher Knowledge is therefore essential for ensuring effective instruction and cultivating a new generation of scientifically literate individuals.

Literature review

Teaching chemistry requires a multifaceted knowledge base that includes content understanding, teaching skills, and practical experience. This article explores various aspects of chemistry teachers' knowledge and their implications for effective teaching.

Content knowledge refers to the teacher's deep understanding of the concepts and theories of chemistry that he is teaching. This allows them to explain concepts clearly, address student misconceptions, and

connect different topics coherently. Research shows that teachers with strong content knowledge demonstrate greater confidence in teaching and deliver more engaging lessons.

Pedagogical content knowledge includes an understanding of how to teach chemistry effectively. It includes knowledge about student learning, teaching strategies, and assessment methods. Teachers with deep knowledge of pedagogical content can make informed decisions about sequencing and connecting content, differentiate instruction, and use effective questioning techniques. This knowledge helps them create meaningful learning experiences that meet the diverse needs of students.

Practical knowledge includes the practical skills and experience needed to teach chemistry experiments safely and effectively. It includes knowledge of laboratory equipment, safety procedures, and troubleshooting techniques. Teachers with practical knowledge can confidently lead practical lessons to promote student engagement and understanding. They can also tailor experiments to

Given the importance of chemistry teachers' knowledge, it is important to explore strategies to improve it. This paper discusses professional development programs, teacher education institutions, and school-based initiatives that can assist teachers in developing a comprehensive understanding of chemistry and effective teaching practices.

Professional development programs provide teachers with the opportunity to deepen their content knowledge, improve their teaching skills, and gain practical experience. These programs may include workshops, conferences, online courses, and mentoring programs. Effective professional development programs are tailored to teachers' specific needs and provide ongoing support.

Teacher training institutions play a critical role in equipping future teachers with the necessary knowledge and skills. They should emphasize pedagogical content knowledge and practical skills in their curriculum. Teacher candidates should have ample opportunities to practice, conduct research, and collaborate with experienced teachers.

Schools can also contribute to improving the knowledge of chemistry teachers through initiatives such as peer observation, lesson study groups, and collaborative planning. Peer observations allow teachers to learn from each other's experiences and provide constructive feedback. In lesson study groups, teachers work together to develop and refine effective lesson plans. Collaborative planning promotes knowledge sharing and ensures that teachers are aligned in their instructional goals.

Purpose of the research:

The purpose of the research paper is to examine the Pedagogical Content Knowledge (PCK) of chemistry teachers. It aims to assess the current level of PCK among educators, identify factors influencing its development, and explore its implications on teaching practices and student learning outcomes. Additionally, the paper seeks to provide insights and recommendations for enhancing chemistry education by improving the pedagogical skills and knowledge of chemistry teachers.

Research questions:

1. What is the current level of Pedagogical Content Knowledge (PCK) among chemistry teachers?
2. What factors contribute to the development and acquisition of PCK among chemistry educators?
3. How does PCK influence the instructional practices of chemistry teachers in the classroom?
4. What are the effects of chemistry teachers' PCK on student engagement and learning outcomes?

Methodology

The methodology for reviewing the aspects of chemistry teacher knowledge began with a thorough literature search across various databases using specific keywords and search queries. Articles were screened based on predetermined inclusion criteria, including relevance and publication quality. Data extraction involved identifying variables of interest and developing structured forms for data collection from selected studies. The quality of each study was assessed based on established criteria, paying particular attention to research methodology and potential biases. Synthesis of results included organizing extracted data to identify patterns, trends, and gaps in the literature, utilizing methods such as thematic analysis and narrative synthesis. Critical appraisal was conducted to reflect on the strengths and weaknesses of the review and discuss any inconsistencies or contradictions in the findings. Methodological limitations, such as selective publication bias and language restrictions, were identified and addressed to ensure the integrity of the review process. The conclusion summarized the methodology used and reflected on its effectiveness in achieving the review objectives, providing insights for future research in the field. Finally, all references mentioned in the methodology section were listed to ensure transparency and scholarly integrity.

Sampling:

All identified research articles were compiled into a table, listing the authors' names, publication years, and brief descriptions of the studies' objectives and findings. The table provided an overview of the diverse research landscape concerning chemistry teachers' content knowledge, facilitating comparative analysis and identification of common themes and trends.

Article name (author, year of publication)	Description
Benjamin Sandlin, Jordan Harshman, and Ellen Yezierski (2011)	This study investigates the alignment between high school chemistry teachers' formative assessment goals and the items they use to assess student learning.
Marina Miyuko Akutagawa Tacoshi, Carmen Fernandez (2014)	This article investigates the importance of knowledge of assessment in the pedagogical content knowledge (PCK) of chemistry teachers.
A S Shidiq , A Permanasari, Hernani , and S Hendayana (2020)	This article explores the challenges and opportunities that chemistry teachers faced in creating innovative lab-work activities during the COVID-19 outbreak
Laura Teinholt Finne, Bente Gammelgaard, and Frederik Voetmann Christiansen (2022)	This article investigates students' perceptions of laboratory teaching for quality learning in the absence of traditional laboratory work
Paz B. Reyes, Rebecca C. Nueva España, Rene R. Belecina (2014)	This article proposes a model for teaching and learning in chemistry laboratory instruction based on best practices
Betül Demirdöğen, Deborah L. Hanuscin,	This case study investigates the early

Esen Uzuntiryaki-Kondakci , Fitnat Köseoğlu (2015)	development of preservice chemistry teachers' pedagogical content knowledge (PCK) for teaching the nature of science (NOS) through a two-semester intervention.
Bo Chen, Bing Wei (2015)	This article investigates how chemistry teachers' pedagogical content knowledge (PCK) influences their use of curriculum materials.
Onno De Jong, Jan H. Van Driel, Nico Verloop (2001)	This article presents the results of a study on the study of pedagogical content knowledge (PCK) of future chemistry teachers in the framework of a postgraduate teacher education program.
Daphna Mandler, Rachel Mamlok-Naaman, Ron Blonder, Malka Yayon and Avi Hofstein (2012)	This article argues for the use of environmentally oriented curricula in high-school chemistry teaching.
Fer Coenders, Cees Terlouw, Sanne Dijkstra, Jules Pieters (2010)	This article presents a case study of the effects of a chemistry curriculum reform on teachers' professional growth.
Oluwatosin Victor Ajayi (2017)	This article investigates the relationship between teachers' content knowledge, qualifications, experience, and students' achievement in chemistry, finding that all three factors are positively correlated with student achievement.
Marissa Rollnick, Judith Bennett, Mariam Rhemtula, Nadine Dharsey and Thandi Ndlovu (2008)	This article investigates the relationship between subject matter knowledge (SMK) and pedagogical content knowledge (PCK) in the teaching of chemistry.

The **data collection** process involved systematically gathering information from selected research articles identified through the literature search. Relevant data, including authors' names, publication years, study objectives, and key findings, were extracted and compiled into a structured database. Articles meeting predetermined inclusion criteria were meticulously reviewed to ensure accuracy and comprehensiveness of the collected data. Special attention was paid to identifying patterns, trends, and common themes across the selected studies. The data collection phase adhered to rigorous protocols to maintain the integrity and reliability of the gathered information.

In the **data analysis** section, various methods were employed, starting with a descriptive analysis of the main characteristics and data distribution. Following this, a comparative analysis was conducted to

identify common themes and differences among the selected articles. Thematic analysis and visual representation of data were utilized to uncover key themes and relationships. Interpretation of the results allowed for the identification of major findings and recommendations for further research in the field.

Result

In the results section, the findings from the data analysis were presented and discussed in detail. The section began with a summary of the characteristics of the selected articles, including publication years, authors, and research objectives. Key themes and patterns identified through the analysis were then outlined, highlighting commonalities and differences among the studies. Additionally, any significant findings related to chemistry teachers' content knowledge were elaborated upon, along with their implications for the field of education. Finally, the section concluded with a discussion of the overall trends observed and their relevance to the research objectives, providing insights for future studies.

Article (Author, Year)	Influences	Frequency	Percentage
A S Shidiq, A Permanasari, Hernani, and S Hendayana (2020) Laura Teinholt Finne, Bente Gammelgaard, and Frederik Voetmann Christiansen (2022) Paz B. Reyes, Rebecca C. Nueva España, Rene R. Belecina (2014)	Technological knowledge	3	25%
Marina Miyuko Akutagawa Tacoshi, Carmen Fernandez (2014) Benjamin Sandlin, Jordan Harshman, and Ellen Yezierski (2011)	Assessment knowledge	2	16,7%
Jan H. Van Driel, Onno De Jong, Nico	Content knowledge	7	58,3%

Verloop (2001) Betül Demirdöğen, Deborah L, Hanuscin, Esen Uzuntiryaki-Kondakci , Fitnat Köseoğlu (2015) Oluwatosin Victor Ajayi (2017) Marissa Rollnick, Judith Bennett, Mariam Rhemtula, Nadine Dharsey and Thandi Ndlovu (2008) Bo Chen, Bing Wei (2015) Daphna Mandler, Rachel Mamlok-Naaman, Ron Blonder, Malka Yayon and Avi Hofstein (2012) Fer Coenders, Cees Terlouw, Sanne Dijkstra, Jules Pieters (2010)			

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