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CONTENT

BIOLOGICAL SCIENCES

MEDICAL SCIENCES

PEDAGOGICAL SCIENCES

PHILOLOGICAL SCIENCES

TECHNICAL SCIENCES

BIOLOGICAL SCIENCES

SOME SPECIES AND FORMS OF THE TASHKENT BOTANICAL GARDEN (UZBEKISTAN), RECOMMENDED FOR USE IN VERTICAL GARDENING

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Tashkent Botanical garden named after Academician F.N. Rusanov
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Abstract
The article provides data on some promising species of the Tashkent Botanical Garden recommended for vertical gardening.
Keywords: vertical gardening, assortment, landscape design, perspective, decorative, Tashkent Botanical Garden, Uzbekistan.

The importance of decorative trees in ensuring environmental sustainability, as well as greening settlements, is highly appreciated in the world. Today, one of the main problems in urban planning is the organization of landscaping on a scientific basis. Currently, the global warming process is being observed all over the world. This, in turn, has an impact on the ecological environment.

Landscaping of settlements – cities, districts, villages – is one of the main means of landscaping these places. Special attention is paid in the resolutions of the President and the Government of the Republic of Uzbekistan to the improvement of settlements. The expansion of the range of decorative species of trees and shrubs used in landscaping, the search for varieties and forms that can adapt to the conditions of our country, the introduction of scientifically based technology care are topical issues of today.

It is known that trees and shrubs absorb carbon dioxide from the air and enrich the air with oxygen. 1 ha of green spaces absorbs 8 kg of carbon dioxide from the air in an hour. The same amount of carbon dioxide is released by 200 human lungs when breathing. In other words, the moderate air content required for breathing of 1 person in the city is provided by green spaces with an area of 50 m^2. But most of the carbon dioxide is dispersed in the atmosphere, and only a small part is absorbed by green spaces.

As is known, in nurseries specializing in the breeding and cultivation of ornamental species of trees and shrubs, it is relevant to study the bioecological features of promising plants, study the factors affecting their growth and development, as well as improve various breeding methods for landscaping. Most of the assortment currently used in the field of landscaping in our republic consists of introduced shrubs. Climbing plants are of particular importance in the landscaping of settlements. Their importance is invaluable, especially in newly constructed buildings, as newly planted trees and shrubs will not yet grow and develop well. During the period when the construction was completed, the use of climbing plants to create a green landscape is the main tool of landscape design. The expansion of human settlements in the world requires the widespread introduction of landscape design and landscaping in accordance with the traditions of modern urban planning. Decorative species of trees and shrubs that are biologically resistant to urban conditions are of particular importance here, the determination of their resistance to environmental factors, the assessment of decorative properties and the development of reproduction methods in various conditions are of great scientific and practical importance.

Rooftop landscaping is very popular in Europe. The green and flower-covered roofs are very beautiful and emphasize the aesthetics of the building. Green roofs improve thermal insulation, reduce dustiness of the air, increase the noise protection of the room, protect the roof from ultraviolet rays, and purify rainwater, so that pollution and soil erosion are not observed. Vertical landscaping, in harmony with the walls of the fence, as well as with the walls of houses and balconies, gives the rooms beauty and grace. Climbing plants decorate the entrances to buildings, making them decorative and cozy. With the skillful use of green plants in the vertical landscaping of walls and corners of the building, their architectural appearance becomes more expressive. Climbing plants are also of great importance when hiding inconspicuous side parts of buildings. However, excessive vegetation can lead to clogging of architectural parts of the building. Green plants should not cover the brick, ceramic texture. Only in places with high solar radiation, the walls of buildings can be completely covered with green climbing plants. This method is most often used in hospitals and sanatoriums. Climbing plants are also more often used in the design of small and large verandas.

The following plants are used in vertical gardening: wild grapes of different varieties (vines), Amur vine, clematis, honeysuckle, actinidia, kirkazon (aristolochia), ivy, lemongrass, etc.; when landscaping balconies and verandas, from annual, climbing plants – nasturtiums, ipomoea, Japanese hops, Gourd (Bottle gourd), sweet peas and beans. But the full-fledged decorative appearance of these plants manifests itself in the middle of summer or autumn. For landscaping verandas and pergolas, it is recommended to use the following plants: from woody stems – grapevine (grapes), moonseed, clematis (clematis), honeysuckle-caprifol, aristolochia, climbing roses and climbing hydrangea; from herbaceous – hops, gladiantha (*Thladiantha*), bryonia

(*Bryonia*); from annual – ipomoea, Turkish pods, sweet peas.

The assortment for landscaping roofs should be chosen carefully, they should be light-loving, wind-resistant, adapt well to new living conditions, have a small root system, be drought- and frost-resistant. Vertical landscaping helps to make the walls of buildings aesthetically attractive in a short time, to create dense and beautiful panels. Lianas, ferns, mosses, perennial mountain plants are used for landscaping walls, which are unpretentious, adapt well to life on vertical surfaces and help to quickly cover the surface of the wall. Vertical plant curtains help to reduce the temperature of the wall surface, increase biodiversity, protect from noise and dust, have a positive effect on the psychological state of a person, and allow you to decorate the styles of rooms. Vertical landscape design in a modern interpretation was invented by Stanley Hart White at the American University in Urbana-Champaign, Illinois, between 1931 and 1938. Modern vertical gardening has a number of advantages: with a total large area of green mass, it does not take up much space, creates a good mood, allow you to relax, relieve stress. We can use several types of plants at once. Plants growing in a vertical plane actively absorb carbon dioxide and saturate the air with oxygen. A room with a vertical living wall creates a unique microclimate, reminiscent of the atmosphere of a real garden. Vertical gardening can be arranged in a specific place or room using simple plants such as moss. Moss forms a real green wall. The table below shows the species and forms available in the Tashkent Botanical Garden, recommended for use in vertical gardening (table).

Table

Species and forms of the Tashkent Botanical Garden recommended for use in vertical gardening

1	**Aristolochiaceae**	*Aristolochia*	*durior* Hill
2		*Aristolochia*	*tomentosa* Sims
3		*Aristolochia*	*clematitis* L.
4	**Ranunculaceae**	*Clematis*	*virginiana* L.
5		*Clematis*	*orientalis* L.
6		*Clematis*	*tangutica* Maxim. Korsh.
7		*Clematis*	*songarica* Bunge
8		*Clematis*	*serratifolia* Rehder
9		*Clematis*	*flammula* L.
10		*Clematis*	*vitalba* L.
11		*Clematis*	*viticella* L.
12		*Clematis*	*paniculata* J.F. Gmel.
13	**Araliaceae**	*Hedera*	*colchica* (K. Koch)
14		*Hedera*	*helix* L.
15		*Hedera*	*pastuchovii* Woronow
16		*Hedera*	*helix* var. *"Esther*
17			*helix* var. *"gloire de Marengo"*
18			*helix* var. *"Goldchild"*
19			*helix* var. *"tricolor"*
20	**Apocynaceae**	*Periploca*	*graeca* L.
21		*Vinca*	*herbacea* Waldst. & Kit.
22			*major* L.
23			*minor* L.
24		*Apocynum*	*lancifolium* Russ.
25		*Apocynum*	*scabrum* Russ.
26		*Trachelospermum*	*jasminoides* (Lindl.) Lem.
27	**Bignoniaceae**	*Campsis*	*radicans* (L.) Bureau
28			*grandiflora* (Thunb.) K.Schum.
29		*Bignonia*	*capreolata* L.
30			*unguis-cati* L.
31	**Fabaceae**	*Wisteria*	*chinensis* (Sims) DC.
32		*Clematis*	*vitalba* L.
33	**Caprifoliaceae**	*Lonícera*	*caprifólium* L.
34			*x brownii* (Regel) Carriere

***Hedera helix* L.** – Common ivy, European ivy is a species of flowering plants in the Araliaceae family. It is widespread in some parts of Europe and Western Asia. It is popular as an evergreen ornamental plant growing on tree trunks, walls and hedges of gardens. It grows up to 20-30 m in height, also known as a species that covers the ground where there are no tree trunks, rocks, rotting walls or vertical surfaces. It is raised with the help of aerial roots with "pads" tightly adjacent to the substrate. As a rule, it grows best in areas with a large range of soil pH (ideal pH = 6.5), preferring moist shady places and avoiding direct sunlight, which can

cause drying in winter [1]. The leaves are alternate, 50-100 mm long, the leaf petiole is 15-20 mm; they come in two types: young leaves with five palmate lobes on creeping and climbing stems and large heart-shaped leaves on profusely flowering stems open to full sunlight, usually grows in the crowns of trees to the tops of high cliffs (Fig. 1).

Figure 1 – General view *of the* growth *of* Hedera helix *L.*

The flowers bloom from late summer to late autumn, small, 3-5 cm in diameter in umbellate inflorescences, greenish-yellow, very rich in nectar, which are an important food source for bees and other insects in late autumn. Fruits with a diameter of 6-8 mm, from purplish-black to orange-yellow, ripen in late winter [2] and are an important food source for many birds. Each berry contains from one to five seeds, which spread after being eaten by birds. In Europe, it is often planted to cover walls, and the Bavarian government recommends growing it in buildings because of its ability to cool the interior in summer, provide insulation in winter, and protect the interior from soil moisture and temperature [3-5].

***Humulus lupulus* L.** – Common hops are from the family Cannabaceae, a perennial vine of the genus Humulus L. The stem is curly clockwise, four–sided, hollow, covered with sharp thorns, up to 7 m long. The rhizome is long, creeping. The leaves are three- to five-lobed, heart-shaped, ovate with sharp edges, large-filiated at the edges, opposite, long-stemmed, with internodes; the upper leaves are whole. They are dioecious. The male inflorescences on the branches of the second order consist of dichasias, which turn into whorls. The male flowers are small, green, and consist of a five-petaled inflorescence and five erect filamentous stamens. Inside the complex oval-shaped inflorescences are female flowers. The staminate flowers arranged in pairs are racemose inflorescences of underdeveloped leaves with folds of two to four to six flowers in the axils without flowers of the first order. The lupolysts fuse with the fruit and consist of yellow glands containing lupulin. Female flowers consist of an achene, membranous at the base, surrounded by a whole cup-shaped inflorescence at the edges. It blooms in July and August. The nut fruit, consisting of a spirally coiled whorl, ripens in August-September (Fig. 2).

Figure 2 – General view *of the* growth *of* Humulus lupulus L. in *the* Tashkent Botanical Garden

The plant is widespread in the temperate climates of Eurasia and North America; it is also found in northern Africa (in Morocco). The plant's homeland is unknown. In Russia, it is widespread almost everywhere, except in the Far North, the Caucasus and Altai, in the European part and Western Siberia. It grows along riverbanks and in deciduous forests, in shrub forests, on willow and alder soils. It has long been grown on special plantations. Hop fruits contain essential oil (up to 3%), hop resins, wax, bitter substances (16-26%, according to other sources 11-21%), valerian, hop acids, glycoside lupulin, carotene, ascorbic acid, choline, thiamine, nicotinic acid, yellow dyes, tannins, contains tannins (3%), flavonoids. Young branches and leaves contain 0.095-0.19% ascorbic acid. The essential oil of hops is fragrant, light or orange in color, the main component of which is myrcene (30-50%) and myrcenol. Hop resins are a complex complex of substances (a mixture of phenols, tar acids and neutral resins). The quantitative composition of phenols and resin acids determines the brewing value of a particular hop variety. The composition of bitter substances varies depending on the hop variety and growing conditions (climate and soil), as well as on the time of harvest. The fruits of hops, which used to be called “hooters”, were used for dyeing fabrics. Bees collect pollen from hops. An ornamental, climbing, creeping plant is grown to decorate hedges and balconies. Long stems can be used to produce fiber suitable for making coarse burlap and ropes [6].

The fruits of hops harvested at the beginning of maturation have long been used in brewing and baking (for the production of liquid yeast), in baking some types of bread. Hop tannins regulate fermentation and prevent beer fermentation. Essential oil, resin, and lupulin give beer its characteristic aroma and bitter taste [6]. Newly emerged young branches of hops are eaten in spring in vegetable dishes such as asparagus or cauliflower, and as nettles for green cabbage soup [7]. Hops are a moisture-loving and heat-loving plant. The sum of temperatures for its development averages 2,600 °C. The optimal average daily temperature is 16-18 °C. The optimal annual precipitation is 450-650 mm; relative humidity is 70-80%. Ordinary hops are demanding on the type of soil. It develops well on fertile soils with a slightly acidic reaction. Chernozems, gray forest, light and loamy soils are best suited. Sandy, carbonate and swampy soils are unsuitable. It absorbs 3.5-4 times more nutrients (NPK) from the soil than winter wheat. It is considered a plant sensitive to zinc deficiency in the soil [8]. Information about the biochemical composition of Humulus lupulus, its role in the pharmaceutical industry, and its medicinal properties can be found in many foreign literatures [9-14].

***Lonicera caprifolium* L.** – a liana of the Caprifoliaceae family, reaching 6 m in height, growing mainly in temperate regions. Homeland – Central and Southeastern Europe, the Caucasus. Distribution: Albania, Austria, Bulgaria, Czechoslovakia, Germany, Greece, Hungary, Italy, North Caucasus, Romania, Turkey, Yugoslavia. Introduced: Belgium, Dominican Republic, France, Great Britain, Haiti, Ireland, Crimea, Michigan, New Jersey, New York, Norway, Nova Scotia, Ontario, Poland, South European part of Russia, Spain, Sweden, Switzerland and Uzbekistan [15]. The young branches are light green, sometimes purple, and the bark is brown on the old branches. The leaves are opposite, broadly elliptical, 4-10 cm long, dark green above, gray below. The flowers are yellowish-white, often reddish on the outside, collected in the axils of leaves fused at the top. The corolla is 4-5 cm long, double-edged. The flowers are fragrant, mostly late, and fragrant. The flowering

period is from May to July. The fruits are inedible, orange or red in color, 6-8 mm in diameter; do not fuse with each other. The fruit is short, so the fruits look as if they are "glued" to the leaf. It ripens in late July-August (Fig. 3).

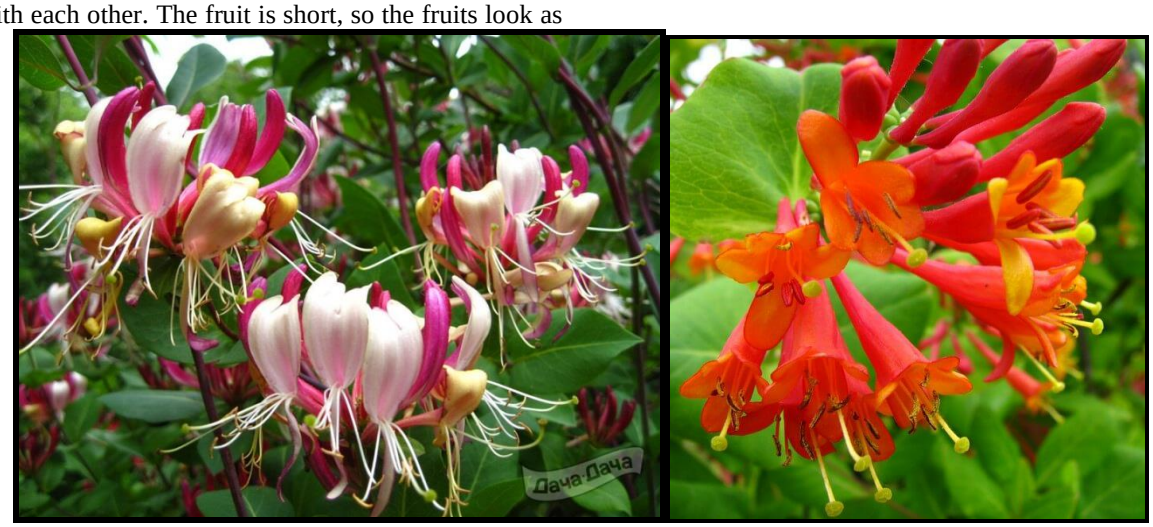

Figure 3 – Lonicera caprifolium L. during *the* flowering period

Lonicera caprifolium is often used in vertical gardening as a promising decorative garden plant. It is very unpretentious, grows quickly and is well resistant to formative pruning. Kaprifol is light-loving, demanding of soil fertility and moisture. It is propagated by seeds, cuttings, but it is very easily propagated by root layering. Caprifol flower extract is used in the perfume industry and aromatherapy [16].

Thus, vertical gardening in landscape design is a popular trend today. It has both aesthetic and practical significance. A hedge of climbing plants can be used to create so-called green rooms. For this purpose, fences, screens in the form of lattices made of wood, plastic nets, weaves made of willow and walnut rods are supported.

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MEDICAL SCIENCES

ASSOCIATION OF GLIOBLASTOMA WITH MENTAL STRESS

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Abstract

Gliomas tend to have a poor prognosis and are the most common primary malignant tumors of the central nervous system. Compared with patients with other cancers, glioma patients often suffer from increased levels of psychological stress, such as anxiety and fear. Chronic stress is thought to impact glioma profoundly.

However, because of the complex mechanisms underlying CS and variability in individual tolerance, the role of CS in glioma remains unclear[2]. This review suggests to study deeper potential role of chronic mental stress in gliomas, particularly glioblastoma, etiology, pathogenesis. Mental stress management among population may lead to better results in gliomas prevention and treatment. After diagnosis, glioblastoma [GBM] patients undertake tremendous psychological problems such as anxiety and depression, which may contribute to GBM progression. However, systematic study about the relationship between depression and GBM progression is still lacking [1]. Given the negative impact of maladaptive psychosocial and biobehavioral factors on normal immune system functions, the question remains as to how psychological conditions potentially affect the brain tumor patient anti-tumor immune response [3]. Since immunotherapy has yet to show efficacy at increasing malignant glioma patient survival in all randomized, phase III clinical trials to-date, this review provides new insights into the potential negative effects of chronic distress on brain tumor patient immune functions and outcomes [3]. Central nervous system [CNS] tumors account for 1.6% of all newly diagnosed cancers worldwide according to Global Cancer Statistics 2020 [4], with gliomas being the most common primary CNS tumors, accounting for approximately 75%. from all detected [5]. In this article we will talk about gliomas and what them belong to chronic stress. How to decrease risk factors of initiation of brain oncology.

Keywords: gliomas, glioblastomas, chronic stress, brain tumors.

Mental stress in patients with a brain tumor

Stress is a normal and fairly common human reaction that helps overcome difficulties in critical periods. The reaction to stress can have different manifestations and is called acute stress. However, long-term effects of stressful factors, especially in people with an irrational diet or sleep disorders, can lead to the transition of acute stress to the stage of exhaustion, when cells lose the ability to maintain their functional properties: chronic stress develops [6]. Cohort studies show that mood disorders such as depression and anxiety [7] are observed significantly more often in patients after diagnosis and increase during treatment and operations [8]. Numerous studies have shown that the relationship between chronic stress and glioblastomas is direct and bidirectional. However, the primary question remains open: chronic causes glioma or chronic stress causes glioma [9]. However, sudden onset depression and anxiety can also be early symptoms of glioma. While neuropsychiatric symptoms are the first clinical sign of a brain tumor in 18% of reported cases [10]. In this paper, we will try to reveal the connection between chronic stress and glioblastomas. Let's consider how certain mechanisms affect the progression of these tumors and how it can be combated. Depression and anxiety are common in patients with a terminal illness. Meta-analyses have found that cancer patients in the palliative care setting have a rate of mood disorders, including depression, anxiety, and adjustment disorder, of 29%. Notably, this rate of psychological conditions is likely underappreciated and/or underreported, as cancer patients experience chronic distress and demoralization without the presence of a psychiatric diagnosis [11].

Molecular mechanisms of Mental stress in patients with a brain tumor

The effect of chronic stress on both humans and laboratory rats is realized by a rather complex pattern of interactions. Thus, the system can be divided into receptors that directly determine stressors, processing and reaction centers [12]**.** With the help of long-term neural connections, information enters the processing center - the Limbic system. The adreno-cortisol apparatus, controlled by the Pituitary-hypothalamus-adrenal axis, serves as the body's response to one or another stress factor. The sympathetic nervous system also assumes its role in regulation [13]**.** During the action of the stressor, the sense organs collect information about it and transmit impulses to the primary cortex of their area, respectively. Then, through a complex system of interactions, the impulses are transmitted to the thalamus for cortico-thalamic integration. The thalamus

plays a key role in the development of the stress response, acting as a processing relay station. Here, information is processed and transmitted to areas involved in stress processing. In our case, it is the prefrontal cortex, the amygdala and the hippocampus. The prefrontal cortex is responsible for the complex behavioral responses associated with the stress response, while the hippocampus is responsible for the creation of long-term memories associated with chronic stress. The amygdala activates the ways of integration of the nervous system with the neuroendocrine system, initiating the pituitary-hypothalamus-adrenal axis [14 15 16 17]. It is clear that the processing of stress involves huge arrays of neural interactions and cannot fail to affect the functions of whole parts of the brain. Chronic stress can cause an imbalance between excitatory and inhibitory neurotransmission, which leads to a change in the strength and stability of synapses. Research on rats revealed that under the influence of chronic stress, the activity of such parts of the brain as the lateral and basolateral gyrus, the lateral habenula, significantly increased.[18] At the same time, the synaptic plasticity of neurons was disturbed in the hippocampus and prefrontal cortex. These changes are also characteristic of patients with mood disorders. Pathomorphologically confirmed reduction in the mass of neurons of the prefrontal cortex, reversible damage to the hippocampus and hypertrophy of the amygdala. However, damage is relative, because different individuals have different resistance to stress [19 20 21]**.** Signals evoked in response to chronic stress converge in the paraventricular nuclei, the control nucleus of neuroendocrine pathways [22]**.** Activation of the pituitary-hypothalamus-adrenal axis is triggered by the release of corticotropin-releasing hormone and arginine-vasopressin. Hormones bind to corticotropin-releasing hormone receptor 1 [CRHR1] on corticotropic cells of the anterior pituitary, leading to the synthesis and secretion of adrenocorticotropic hormone [ACTH]. ACTH then acts on the adrenal cortex to stimulate the synthesis and release of glucocorticoids [GC] [23 24], characterized by cortisol in humans and corticosterone in rodents [25]**.** This neurological transmission also activates the sympathetic nervous system, which stimulates the release of catecholamines. Arasympathetic regulation is represented by the vagus nerve. In addition, the vagus nerve is an important hub of the microbiota-gut-brain axis [25]**.** Chronic stress creates a powerful effect on the body. It acts through the central nervous system, disrupting the balance between the sympathetic and parasympathetic nervous systems. As a result, excessively synthesized stress signaling molecules constantly circulate in the blood and cerebrospinal fluid, as a result of constant activation of the adrenal and cortisol systems [26]**.** High levels of these factors affect the immune response and can cause inflammation. At the same time, a violation of vagal inhibition can have a negative effect on the gut microbiota, increasing conductivity, which only leads to an exacerbation of the process [27]**.** Inactivation of tumor protein 53 [p53] is a critical event in the malignant transformation of most tumor cells [28]**.** In vivo studies in rats have confirmed that chronic stress stimulates NE to initiate G-protein-protein kinase A [Gs-PKA] signaling through β2 - adrenoceptors [β2 - AR]. As a result, reactive oxygen species are formed that damage cellular deoxyribonucleic acid, with the accumulation of metabolites of the latter in the cytosol if the repair is damaged. In addition, cytosolic β-arrestin1 [ARRB1] mediated NE-induced protein kinase B [AKT] and murine two-minute activation 2 [MDM2], while nuclear ARRB1 acted as a catalyst for MDM2-dependent p53 ubiquitination, promoting p53 degradation and DNA damage in the frontal parts of the cerebral cortex [29]**.** Meanwhile, high levels of GCs during chronic stress mediate the effects of chronic stress on p53 through the induction of serum and glucocorticoid-regulated kinase 1 [SGK1], which in turn increases MDM2 activity and decreases p53 function [30]**.** Clinical data also suggest that loss of p53 function is a key initiating event in glioma development [31]**.** It is also important to clarify that p53 protein damage alone is not sufficient for tumorigenesis. As far as we know, mutations must accumulate and be passed on to subsequent generations of cells to initiate progression [32]**.** Gliomas are common in the frontal and temporal lobes of the human brain, but there is still insufficient evidence that DNA damage in these regions specifically initiates glioma formation [33]**.** Prolonged proliferation is the most important characteristic of glioma cells. Serum levels of the stress hormones GC and NE have been shown to increase significantly under chronic stress. NE and GC promoted uncontrolled proliferation of gliomas in vivo, and in vitro experiments using human glioma cell lines showed that GC and NE promoted glioma cell growth by activating phosphoinositide 3-kinase**,** protein kinase B. The signal is transmitted through glucocorticoid receptors and β- adrenoreceptors [β-AR] [34]**.** At the same time, β-ARs initiate extracellular phosphorylation of signal-regulated kinase [ERK], enabling them to exert a direct influence on the proliferation of glioma cells [35]**.** AKT pathways are non-alternative intracellular signaling pathways involved in cell growth, division and apoptosis. In addition, the ERK phosphorylation cascade is a central regulator of intracellular signaling. NE also directly promoted proliferation by regulating cyclin D1/cyclin-dependent kinase 4/6 [CDK4/6] expression in glioma cells [36]**.** The data show that glutamatergic synapses form between neurons and cells, and this trend is observed in both rats and humans. Neuronal activity mediated by the α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid [AMPA] receptor has also been shown to induce glioma invasion and growth. During this growth, neurons also released neuroligin-3 to activate the mammalian phosphoinositide 3-kinase target of rapamycin pathway in glioma cells and promote glioma cell proliferation [37]. At this time, there are no visual studies that would confidently demonstrate a correlation between chronic stress and the formation of excitatory synapses. However, researchers [38] found that gamma-aminobutyric acid [GABAergic] interneuron activity is reduced in rats after chronic visual deprivation, a form of chronic stress. This condition leads to increased proliferation of glioma in the primary visual cortex. Unlike glutamatergic

synapses, which transmit excitatory signals, GABAergic neurons are the main inhibitory neurons of the CNS. Thus, chronic stress disrupts the balance between excitatory and inhibitory signals in the brain. In such conditions, the sensitivity of cells to excitatory influences increases, which in turn can contribute to the establishment of excitatory synapses between neurons and gliomas [39]**.** Chronic stress has recently been implicated as a cause of vision loss in patients with glioma [40]**.** While it was possible to prove interrelated factors of chronic stress and complications of glioma in mouse models, it is still quite problematic to do this in human lines in vitro. Although clinical observations indicate this, stress hormones synergize this process and stimulate the proliferation of glioma cells. Chinese scientists in 2023 used further method to study molecular mechanisms Chronic stress accelerates glioblastoma progression via DRD2/ERK/β-catenin axis and Dopamine/ERK/TH positive feedback loop: Chronic unpredictable mild stress and chronic restrain stress were used to mimic human depression in mice. Human GBM cells and intracranial GBM model were used to assess the effects of chronic stress on GBM growth. Targeted neurotransmitter sequencing, RNA-seq, immunoblotting and immunohistochemistry were used to detect the related molecular mechanism. The results were further: Chronic stress promoted GBM progression and up-regulated the level of dopamine [DA] and its receptor type 2 [DRD2] in tumor tissues. Down-regulation or inhibition of DRD2 abolished the promoting effect of chronic stress on GBM progression. Mechanistically, the elevated DA and DRD2 activated ERK1/2 and consequently inhibited GSK3β activity, leading to β-catenin activation. Meanwhile, the activated ERK1/2 up-regulated tyrosine hydroxylase [TH] level in GBM cells and then promoted DA secretion, forming an autocrine positive feedback loop. Remarkably, patients with high-depression exhibited high DRD2 and β-catenin levels, which showed poor prognosis. Additionally, DRD2 specific inhibitor pimozide combined with temozolomide synergistically inhibited GBM growth. The conclusion of this study was: The study revealed that chronic stress accelerates GBM progression via DRD2/ERK/β-catenin axis and Dopamine/ERK/TH positive feedback loop. DRD2 together with β-catenin may serve as a potential predictive biomarker for worse prognosis as well as therapeutic target of GBM patients with depression [1].

Interactions among distress, immunosuppression, and cancer

Untreated distress may affect brain tumor patient outcomes through the interactions between psychosocial distress and the immune system. The relationship between excess adrenergic signaling and immune dysregulation, inflammation, and tumor growth is well-established. Increased distress promotes the release of stress hormones, primarily in the form of catecholamines including epinephrine and norepinephrine via the sympathetic nervous system [SNS], as well as glucocorticoids via adrenal cortex [3].

Conclusions

The effect of chronic stress on the initiation, proliferation, and progression of gliomas is a controversial topic. A growing number of recent preclinical studies have shown that chronic stress does promote tumorigenesis. However, some meta-analyses of cohort studies still refute the effect of long-term work stress, as well as the disruption of circadian rhythms due to night shifts do not have an effect on the risk of cancer [41]. Many subsequent studies have shown that mood disorder and chronic stress have an important impact on the prognosis of patients with glioma. Recently, there is increasing evidence that chronic stress as a concomitant risk factor may contribute to the development and progression of glioma. The related molecular and systemic mechanisms mentioned above have been discovered in animal studies, and most of them have been clinically confirmed in patients with various types of cancer. Individual responses to stress may vary, so the effect of stress on glioma risk may vary from person to person. Some patients can take steps to prevent stress, such as walking, spending time with loved ones, pets, etc., potentially reducing the risk of developing cancer. Others may use negative coping strategies, such as overeating, drinking, or smoking, which can increase the risk of developing cancer. But despite such a large sample, more detailed studies still show a link between chronic stress and the development of gliomas. [41] It is summarized that chronic stress is associated with glioma by affecting eight hallmarks of cancer, namely genomic instability and mutation, unlocking phenotypic plasticity, maintaining proliferative signaling, reprogramming cellular metabolism, resistance to apoptosis, activation of invasion and metastasis, inflammation, tumor-promoting and polymorphic microbiomes. In turn, gliomas contribute to mood deterioration and the emergence of chronic stress as such, worsening the prognosis. Malignant brain tumors are a profoundly devastating disease associated with significant increases in depression, anxiety, and distress among patients. We propose a direct biological link between psychosocial stressors and poor outcomes in malignant glioma patients. High adrenergic signaling and endogenous steroid activity may impair immune system functions, resulting in the uncontrolled proliferation of tumor cells, as observed in non-CNS cancer patients. The influence of chronic mental stress [CMS] on gliomas is a controversial topic. An increasing number of recent preclinical studies have shown that CMS promotes tumorigenesis. However, some meta-analyses of cohort studies suggest that long-term work stress and chronic jetlag caused by night shift work do not increase the risk of cancer. Many follow-up studies have shown that CMS and CMS-induced mood disorders were important prognostic factors for glioma. There is also increasing evidence that CS as an environmental risk factor can promote the development and progression of glioma. Associated molecular and systemic mechanisms have been identified in animal studies and most have been demonstrated in cancer patients. However, association of gliomas, particularly glioblastoma – the most spread and high mortality glioma, with mental stress has to be studied further. New knowledges about this association may lead to better results in gliomas prevention and treatment through effective chronic mental stress management strategies [42].

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PEDAGOGICAL SCIENCES

L'UTILIZZO DI STRUMENTI DIGITALI NELL'INSEGNAMENTO DELLE LINGUE

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THE USE OF DIGITAL TOOLS IN LANGUAGE TEACHING

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Abstract

L'utilizzo di strumenti digitali nell'insegnamento delle lingue rappresenta una pratica sempre più diffusa e efficace nel contesto educativo contemporaneo. Con l'avvento delle nuove tecnologie e l'ampia disponibilità di risorse online, i docenti hanno a disposizione un vasto arsenale di strumenti digitali che permettono di arricchire e potenziare il processo di apprendimento delle lingue straniere. Questo articolo si propone di analizzare tre piattaforme più utilizzate nell'insegnamento delle lingue, nonché le ragioni alla base di questa tendenza in crescita, esaminando i benefici e le sfide che essa comporta.

Abstract

The use of digital tools in language teaching represents an increasingly widespread and effective practice in the contemporary educational context. With the advent of new technologies and the wide availability of online resources, teachers have at their disposal a vast arsenal of digital tools that allow them to enrich and enhance the process of learning foreign languages. This article aims to analyze three most used platforms in language teaching as well as the reasons behind this growing trend, examining the benefits and challenges it entails.

Keywords: e-learning platforms, digital education, foreign languages.

Keywords: piattaforme e-learning, educazione digitale, lingue straniere.

1. Introduzione

L'utilizzo di strumenti digitali nell'insegnamento delle lingue consente di creare un ambiente di apprendimento più coinvolgente e interattivo per gli studenti. Utilizzando risorse multimediali, quali video, audio, immagini e presentazioni interattive (Sowmya et al., 2024), i professori stimolano la curiosità e l'interesse degli studenti, facendo che le lezioni siano più dinamiche e stimolanti. Inoltre, i programmi e le piattaforme online offrono la possibilità di personalizzare l'acquisizione della lingua straniera in base alle esigenze e alle preferenze degli studenti, permettendo loro di migliorare la pronuncia a ritmo individuale e di concentrarsi sugli aspetti grammaticali che necessitano un maggior rafforzamento.

L'utilizzo di strumenti digitali consente di favorire la collaborazione e la comunicazione tra studenti e docenti. Attraverso l'impiego di piattaforme e applicazioni online, è possibile creare spazi virtuali in cui gli studenti possono interagire tra loro, condividere materiali didattici, partecipare a discussioni e lavorare in gruppo su progetti collaborativi. Questo favorisce lo sviluppo delle competenze comunicative e relazionali degli studenti, nonché la capacità di lavorare in gruppo in modo efficace ed efficiente.

Tuttavia, l'integrazione di strumenti digitali nell'insegnamento delle lingue pone anche alcune sfide e criticità. Una delle principali criticità riguarda la necessità di una formazione adeguata da parte dei docenti, al fine di utilizzare in modo efficace e appropriato le tecnologie digitali in classe. È fondamentale che i docenti acquisiscano competenze digitali avanzate e siano in grado di selezionare e utilizzare le risorse digitali in modo efficiente, al fine di massimizzare i benefici dell'apprendimento online. Inoltre, è importante considerare il rischio della dipendenza tecnologica e della perdita del contatto umano nell'ambito dell'insegnamento delle lingue. Se da un lato l'utilizzo di strumenti digitali può arricchire l'esperienza di apprendimento degli studenti, dall'altro è fondamentale mantenere un equilibrio tra l'utilizzo delle tecnologie e le interazioni faccia a faccia tra docenti e studenti. La presenza umana e l'empatia sono elementi fondamentali per favorire l'apprendimento e lo sviluppo delle competenze relazionali degli studenti, e pertanto è importante trovare un equilibrio tra l'utilizzo delle tecnologie e il contatto diretto con gli studenti.

Esiste un'ampia gamma di strumenti digitali a disposizione dell'insegnanti e studenti che possono avere un impatto significativo sul loro percorso accademico. In questo contributo esploriamo i diversi tipi di strumenti digitali accessibili a insegnanti e studenti, analizzandone le funzioni, i vantaggi e le potenziali sfide.

2. Tipologie di strumenti digitali disponibili

Nell'era moderna della tecnologia digitale, l'uso di strumenti digitali in vari campi è diventato indispensabile. Ciò è particolarmente evidente nel mondo accademico, dove sia i docenti che gli studenti sono costantemente alla ricerca di modalità diverse per ottimizzare l'insegnamento e l'apprendimento, per aumentare la produttività e collaborare in modo più efficace. Esiste un'ampia gamma di strumenti digitali disponibili e a portata degli insegnanti e degli studenti che possono avere un impatto significativo sul loro percorso accademico. A continuazione, analizziamo tre strumenti digitali tra i più utilizzati dagli insegnanti e studenti nel campo dell'insegnamento delle lingue straniere.

2.1. *Liveworksheets* è una potente piattaforma che fornisce una grande quantità di esercizi e giochi interattivi che gli insegnanti possono creare, condividere e utilizzare in classe. Questo strumento digitale rivoluziona il modo in cui gli insegnanti interagiscono con gli studenti, rendendo l'apprendimento più dinamico, coinvolgente ed efficace. Oltre alle lingue, Liveworksheets (Mazhminat Jamalova, 2024) offre una vasta gamma di attività in diverse materie, tra cui matematica, lingue, scienze, studi sociali e altro ancora. Grazie a un'interfaccia facile da usare, gli insegnanti possono creare facilmente esercizi personalizzati in base alle esigenze e agli obiettivi di apprendimento degli studenti. Queste attività possono essere arricchite con elementi multimediali come immagini, video e clip audio, rendendo l'esperienza di apprendimento più interattiva e coinvolgente.

Una delle caratteristiche principali di Liveworksheets è la capacità di fornire un feedback immediato agli studenti. Grazie all'autocorrezione e al punteggio immediati, gli studenti possono seguire i loro progressi in tempo reale, identificando le aree di miglioramento e acquisendo una comprensione più profonda dei concetti insegnati.

I fogli di lavoro in tempo reale promuovono anche l'apprendimento collaborativo, consentendo agli studenti di lavorare insieme su esercizi interattivi in tempo reale. Questo ambiente collaborativo incoraggia l'interazione, il pensiero critico e la capacità di risolvere i problemi, favorendo un senso di comunità e di lavoro di squadra tra gli studenti. Inoltre, la piattaforma supporta più lingue, rendendola accessibile a un'ampia gamma di studenti con esperienze linguistiche diverse. Inoltre, la piattaforma offre una raccolta di attività precostituite create da insegnanti di tutto il mondo. Queste risorse possono essere condivise, modificate e adattate alle esigenze delle singole classi, facendo risparmiare agli insegnanti tempo e fatica nella pianificazione delle lezioni. Sfruttando l'esperienza collettiva degli insegnanti di tutto il mondo, Liveworksheets facilita la condivisione delle conoscenze e la collaborazione, arricchendo l'esperienza di insegnamento e apprendimento per tutte le parti interessate.

Liveworksheets può anche essere uno strumento prezioso per effettuare valutazioni di carattere formativo e misurare la comprensione di concetti complessi da parte degli studenti. Grazie agli strumenti di analisi e reporting della piattaforma, gli insegnanti possono analizzare i dati relativi alle prestazioni degli studenti, identificare modelli e tendenze e adattare di conseguenza le proprie strategie didattiche. Questo approccio all'insegnamento basato sui dati consente agli insegnanti di fornire un supporto personalizzato a ogni studente, promuovendo un'esperienza di apprendimento più profonda e significativa.

Concludendo, Liveworksheets è una piattaforma versatile e potente che consente agli insegnanti di creare esperienze di apprendimento coinvolgenti e interattive per i loro studenti. Questo strumento digitale può essere utilizzato per condurre valutazioni formative, analizzare i dati sulle prestazioni degli studenti, promuovere l'apprendimento collaborativo e facilitare la condivisione delle conoscenze tra gli insegnanti. Sfruttando la potenza della tecnologia, Liveworksheets migliora il processo di insegnamento e apprendimento, rendendo l'istruzione più accessibile, coinvolgente ed efficace per gli studenti di tutto il mondo.

2.2. *Lyricstraining* è una piattaforma che offre agli studenti un modo unico e coinvolgente per imparare le lingue attraverso la musica. Questo strumento innovativo fornisce agli utenti video musicali e chiede loro di completare il testo mancante mentre ascoltano la canzone. Combinando la comprensione dell'ascolto con la pratica del vocabolario e della grammatica, Lyricstraining offre agli studenti di lingue un modo divertente ed efficace per migliorare le proprie competenze.

L'interfaccia della piattaforma è facile e intuitiva e consente agli utenti di navigare facilmente tra le diverse canzoni, i livelli e le lingue. Gli utenti possono scegliere tra un'ampia gamma di generi musicali, artisti e canzoni, rendendo più facile la scelta dei brani che corrispondono ai loro interessi e al loro livello di competenza. Che si tratti di un principiante che desidera sviluppare il proprio vocabolario o di un discente avanzato che spera di migliorare le proprie capacità di ascolto, Lyricstraining offre una soluzione a tutti.

Una delle caratteristiche principali di Lyricstraining è il livello di difficoltà adattivo. La piattaforma regola la difficoltà degli esercizi in base alle prestazioni dell'utente, offrendo un'esperienza di apprendimento personalizzata che è al tempo stesso stimolante e gratificante. Questo sistema adattivo garantisce che gli utenti siano costantemente spinti a migliorare le proprie capacità senza sentirsi sopraffatti o scoraggiati. Inoltre, Lyricstraining offre una varietà di modalità di gioco per soddisfare diversi stili di apprendimento e preferenze. Gli utenti possono scegliere tra le modalità "facile", "intermedio" e "difficile", ognuna delle quali offre un diverso livello di sfida. Inoltre, la piattaforma offre agli utenti la possibilità di esercitarsi su abilità linguistiche specifiche come il vocabolario, la grammatica o la comprensione orale, consentendo loro di concentrarsi sulle aree deboli e di monitorare i propri progressi nel tempo.

Un altro aspetto importante di Lyricstraining è rappresentato dalle sue funzioni sociali, che consentono agli utenti di interagire tra loro, di competere in sfide e di condividere i propri progressi sui social network. Questo senso di comunità e di competizione può motivare gli utenti a rimanere impegnati a perseguire i loro obiettivi di apprendimento linguistico, favorendo un senso di amicizia e di sostegno tra gli studenti.

Oltre alle funzioni principali, Lyricstraining offre anche una serie di risorse aggiuntive, come spiegazioni grammaticali, elenchi di vocaboli e note culturali, per aiutare gli utenti ad approfondire la comprensione della lingua e della musica che stanno studiando. Queste risorse forniscono un contesto prezioso e approfondimenti che migliorano l'esperienza di apprendimento e incoraggiano gli utenti a esplorare le sfumature culturali e linguistiche delle canzoni che stanno imparando.

Lyricstraining - come strumento potente e versatile per gli studenti di lingue - combina il fascino universale della musica con il rigore dello studio accademico, offrendo agli utenti una piattaforma dinamica e coinvolgente per migliorare le proprie competenze linguistiche (Adi Isma, 2023). Sfruttando il potere della musica, della tecnologia e della comunità, Lyricstraining offre un'esperienza di apprendimento linguistico olistica e coinvolgente, efficace e divertente.

2.3. *Quizz* è una piattaforma online che è stata progettata per facilitare l'apprendimento interattivo e per la valutazione degli studenti. La piattaforma offre una moltitudine di caratteristiche e funzionalità che la rendono uno strumento indispensabile per le istituzioni accademiche e gli studenti interessati all' approfondimento delle lingue straniere. Dai quiz e dalle valutazioni ai materiali di studio interattivi, la piattaforma offre una soluzione completa per gli studenti che desiderano migliorare le proprie conoscenze e competenze in un ambiente virtuale.

Una delle caratteristiche principali di Quizz è l'interfaccia intuitiva, che consente agli studenti di navigare facilmente all'interno della piattaforma e di accedere ai contenuti di cui hanno bisogno. La piattaforma è stata progettata per essere intuitiva e facile da usare, assicurando che gli studenti possano concentrarsi sui loro studi senza essere impantanati da problemi tecnici. Inoltre, Quizz offre una serie di opzioni di personalizzazione che consentono agli studenti di adattare la loro esperienza di apprendimento alle loro esigenze e preferenze individuali.

Un'altra caratteristica notevole di Quizz è la sua capacità di valutazione. La piattaforma consente agli insegnanti di creare prove ed esami che misurano la comprensione del materiale da parte degli studenti in tempo reale. Questa funzione è utile quando gli insegnanti devono monitorare i progressi degli studenti e fornire una rapida valutazione, contribuendo a garantire che gli studenti raggiungano i loro obiettivi accademici.

Oltre alle valutazioni, Quizz offre una serie di materiali di studio interattivi che coinvolgono gli studenti e migliorano la loro esperienza di apprendimento. Questi materiali includono video, simulazioni ed esercizi interattivi che consentono agli studenti di applicare le loro conoscenze in modo pratico. Incorporando elementi multimediali nel processo di apprendimento, Quizz aiuta gli studenti a memorizzare le informazioni in modo più efficace e a creare collegamenti tra i concetti teorici e le applicazioni del mondo reale. Inoltre, Quizz offre un ambiente di apprendimento collaborativo che incoraggia gli studenti a impegnarsi con i loro compagni e con i docenti. La piattaforma offre forum di discussione, progetti di gruppo e funzionalità di live chat che favoriscono un senso di comunità tra gli studenti e promuovono interazioni significative.

Quizz è considerato uno strumento importante che può migliorare notevolmente l'esperienza di apprendimento degli studenti. La sua interfaccia facile da usare, le solide capacità di valutazione, i materiali di studio interattivi e l'ambiente di apprendimento collaborativo ne fanno una risorsa indispensabile per le istituzioni accademiche e non solo. Tra le risorse online, che possono servire efficacemente come strumenti di valutazione formativa durante le lezioni di lingua straniera, ci sono anche *Kahoot, Wordwall e Mentimeter*, che facilitano i progressi degli studenti e forniscono una valutazione preziosa per lo sviluppo della lingua.

3. Vantaggi dell'utilizzo di strumenti digitali nell'insegnamento

L'insegnamento linguistico è un campo in continua evoluzione in cui l'utilizzo di strumenti digitali ha dimostrato di portare numerosi vantaggi e opportunità per insegnanti e studenti. Secondo Maria Grazia Menegaldo, "l'impiego delle moderne glottotecnologie ha radicalmente modificato l'approccio all'insegnamento linguistico", ciò significa che l'integrazione di tecnologie digitali può migliorare il coinvolgimento degli studenti e favorire la comprensione della lingua. In merito all'integrazione di tecnologie digitali, Constantin Cucoș sottolinea che:

"i mezzi di informazione non sono solo un facilitatore dell'educazione alla conoscenza, ma anche un vero e proprio induttore di nuove informazioni, atteggiamenti e comportamenti con la loro semplice presenza e utilizzo". Lo stesso aggiunge che "le tecniche possono integrare le esperienze di apprendimento faccia a faccia o migliorare la capacità di facilitare esperienze di formazione in tempo reale tra individui (ricerca virtuale, gruppi di apprendimento) sparsi in tutto il mondo (Cucoș, 2023).

Oltre all'aggiornamento continuo, l'innovazione nell'insegnamento delle lingue offre numerosi vantaggi, tra cui:

L'interattività e l'accessibilità perché gli strumenti digitali consentono agli insegnanti di creare attività interattive e coinvolgenti che rendono l'apprendimento delle lingue più stimolante e divertente per gli studenti. Inoltre, l'utilizzo di strumenti digitali consente agli insegnanti di personalizzare l'apprendimento in base alle esigenze e agli interessi degli studenti, migliorando così l'efficacia dell'insegnamento. Gli strumenti digitali permettono agli studenti di accedere al materiale didattico da qualsiasi luogo e in qualsiasi momento, consentendo loro di apprendere in modo autonomo e flessibile. Questo è particolarmente importante per gli studenti che hanno impegni lavorativi o familiari e che potrebbero non essere in grado di partecipare alle lezioni tradizionali in aula.

La valutazione in tempo reale perché ogni piattaforma possiede diversi strumenti per valutare le abilità linguistiche degli studenti e monitorare i loro progressi.

Come strumenti principali di valutazione delle lingue menzioniamo:

a) I test di valutazione delle competenze linguistiche che valutano le abilità linguistiche degli studenti in aree chiave come la comprensione orale, la

comprensione scritta, la produzione orale e la produzione scritta. I test di valutazione delle competenze linguistiche sono utili per individuare le aree in cui gli studenti potrebbero avere bisogno di migliorare e per monitorare i loro progressi nel corso del tempo.

b) Il portfolio linguistico che consente agli studenti di raccogliere e documentare i propri lavori e progressi in un determinato periodo di tempo. Il portfolio linguistico è utile perché consente agli studenti di riflettere sul proprio apprendimento e di monitorare i propri progressi, rendendo l'apprendimento più significativo e autentico.

L'utilizzo di strumenti di valutazione delle lingue offre numerosi vantaggi per insegnanti e studenti. Gli strumenti di valutazione delle lingue sono essenziali per valutare le abilità linguistiche degli studenti e monitorare i loro progressi nel corso del tempo. Utilizzando una combinazione di test di valutazione delle competenze linguistiche, gli insegnanti possono valutare in modo efficace e accurato le abilità linguistiche degli studenti e fornire un feedback significativo e personalizzato che li aiuti a migliorare.

4. Conclusioni

L'uso di piattaforme di e-learning per i corsi di lingua sottolinea il fatto che queste tecnologie hanno un impatto significativo sull'insegnamento e sull'apprendimento delle lingue. Le piattaforme di e-learning offrono feedback personalizzati e suggerimenti per migliorare le prestazioni, arricchendo così l'esperienza di apprendimento degli studenti. La collaborazione e l'interazione tra diverse piattaforme di e-learning potrebbe anche portare allo sviluppo di ambienti di apprendimento più interconnessi e personalizzati. Per concludere, l'apprendimento online per i corsi di lingua ha un enorme potenziale di trasformazione dell'ambiente educativo, offrendo nuove modalità di accesso alla conoscenza e di sviluppo delle competenze linguistiche.

5. Ringraziamenti

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CONSILIERE EDUCAȚIONALĂ ȘI VOCAȚIONALĂ ANGAJAREA PERSOANELOR CU DIZABILITĂȚI "INCLUZIUNEA ESTE BUNĂ PENTRU AFACEREA TA!"

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EDUCATIONAL AND VOCATIONAL COUNSELING EMPLOYMENT OF PEOPLE WITH DISABILITIES "INCLUSIVE IS GOOD FOR YOUR BUSINESS!"

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Abstract

Incluziunea eficientă presupune urmărirea unui parcurs de integrare a persoanelor cu dizabilități atât în școală, cât și mai târziu. Obiectivul prezentei lucrări este de a accentua importanța privirii de către angajatori a persoanelor cu dizabilități nu numai ca potențiali angajați în posturile din firma lor, dar și ca niște colegi egali și respectați.

Abstract

The idea of efficient inclusion consists of not only following a person's with disabilities path in education, but also following that same path through the professional life. The main objective of this paper is to highlight the importance of the employer's view on a person with disabilities not only as a potential job candidate, but also as a respected and equal colleague.

Cuvinte cheie: învățământ special, consiliere școlară și vocațională, cerințe educaționale speciale.

Keywords: special education, school and vocational counseling, special educational requirements.

The treatment and care of people with disabilities appeared a long time ago in human history. For example, at one point during the Renaissance, a revolutionary phenomenon from a scientific, ideological and artistic point of view, which took place between approximately 1300 and 1700, Queen Elizabeth ordered the Government to take care of the needy. Among these needy people, there were also the disabled people of that time, who finally had an institution where they could be hospitalized and assisted in the long term.

During the English Reformation between the 1700s and 1800s, the classification of disabilities began and, much more than that, the first special education initiatives for the visually impaired, the hearing impaired, and more. This side of the reform helped shape a path towards a world where people with disabilities were no longer seen as permanent "patients", but their integration into society was desired.

A disability is a physical or mental impairment that severely limits life activities (such as walking, reading, and communication) as well as essential body functions (immune system functions, cell growth, digestive system, bowel, bladder, neurological functions, cerebral, respiratory, circulatory, endocrine and reproductive).

For people with disabilities, limitations imposed by adverse contexts can be frequent and have a strong impact. The World Health Organization (WHO) characterizes these limitations as more than physical obstacles, but as factors in a person's environment that, by their absence or presence, disrupt functioning and accentuate disability.

These factors may include:

• an environment or physical space partially or totally inaccessible to the person concerned;

• lack of relevant technological means of assistance (assistance, adaptive and recovery devices);

• the general negative attitude of the collective in the context towards disabilities;

• the absence or rudimentary presence of services, systems and policies that encourage the participation of all people with a health condition in all areas of life.

In the United States, the Americans with Disabilities Act (ADA) outlines protections for qualified individuals with disabilities. Under the ADA, the term disability refers to any person who suffers from a physical or mental impairment that may result in a substantial limitation in one or more major life activities.

1. Disabilities in adults: The 6 barriers

Attitude is the starting point of many barriers that people with disabilities face. The attitude aspect refers to stereotypes and prejudices. Many view a person's disability as a tragic shortcoming instead of looking at things proactively.

By a proactive attitude we mean assuming a social responsibility to adapt disabled people to live a fulfilling life.

Communication barriers are common in people who have problems with hearing, speaking or understanding in general. For example, not many products have provisions for the visually impaired, such as a description in Braille. Alternatively, only a few people learn sign language which creates a significant communication barrier for many.

Physical barriers are everywhere. From the moment a disabled person steps out of their own home,

they are faced with many obstacles, from walking on the sidewalk to going down or upstairs.

Political barriers are due to a lack of awareness of disability. Politics has a duty to ensure enforceable laws that guarantee equal participation of all citizens, including those with disabilities. Also, where this aspect is difficult to apply, benefits must still be granted to guarantee decent living conditions.

Social barriers are also everywhere, and follow a person with a disability throughout life. These barriers relate to how people with disabilities grow, learn, work, live and age. For example, people with disabilities are less likely to graduate from high school, find work, or have a good income.

Transportation barriers make people with disabilities dependent on others for everyday things, either unable to drive or without access to convenient private or public transportation. This dependence on others hinders their ability to travel and therefore maintain a stable job.

2. Discrimination of disabled people at work

Discrimination is the unfair or prejudicial treatment of individuals and groups based on characteristics that, in the present case, are related to the spectrum of disabilities.

Discrimination in the workplace has a significant impact on the lives of many, causing some to quit their jobs, feel isolated or even be denied a job. Discrimination in the workplace is still a problem today. For example, more than a third (36%) of UK adults report experiencing discrimination at work.

Direct discrimination occurs in the workplace when a superior or colleague shows prejudice or unfair behavior towards an employee. Direct discrimination can include direct comments, work policies that target certain employees with disabilities, and/or smaller interactions that build a culture of discomfort in the workplace.

Indirect discrimination can occur when all employees are treated the same, but the treatment results in an inherent disadvantage. What constitutes direct and indirect disability discrimination may vary according to local regulations.

Some common examples of disability discrimination at the site of work may include:

• Exclusion of employees with disabilities from the discussion of promotion or other opportunities;

• Refusal to provide assistive technology such as ramps for wheelchairs or screen readers;

• Issuing negative comments or observations towards employees with disabilities;

• The request by the employer or colleagues of the medical history of disabled employees;

• Demotion of an employee after he becomes a disabled person;

• Exclusion from promotion of an employee on the grounds that a member of his family suffers from a disability;

• Influencing the hiring process for people with disabilities;

• Harassment of employees with disabilities.

3. Measures to prevent and combat discrimination against people with disabilities at work

Measures that employers can take to prevent and combat discrimination in the workplace include:

• eliminating or reducing the risks of discrimination based on disabilities;

• offering support to any person with disabilities;

• ensuring that all policies are consistent and consistent with zero tolerance for disability discrimination;

• clarifying to all those in the collective of employees and customers who use the services that discrimination based on disabilities is against the company's policy;

• training staff on recognizing disability-related discrimination and encouraging employees to report such behavior;

• recognizing and promoting the benefits of an inclusive and diverse workforce that does not exclude people with disabilities;

A key advantage of these methods is that they require no resources other than policy writing and in-house training, so they can be adopted by both large companies with complex networks and small companies with a limited number of employees.

4. Benefits of workplace inclusion and employment of disabled people

People with disabilities have diverse perspectives, experiences, abilities and talents. Evidence shows that people with disabilities have a positive attitude to work and that employing people with disabilities can increase productivity and morale in the workplace.

Research published in 2018 demonstrates that the benefits of employing people with disabilities extend throughout the organization or business.

Returning to one of the aspects above, it should be noted that discrimination against disabled people may become less likely to occur when the professional collective is a diverse one.

If employers support and choose, in recruitment, including for people with disabilities, their company can encounter certain benefits such as:

• Attracting a wider pool of talent for jobs at all levels

• Assembling a workforce that reflects more effectively with the client audience but also with the entire community

• recruiting staff who have more resilience and problem-solving skills, skills developed through dealing with their own disability

• bringing new skills to the organization

• improving employee morale by treating everyone fairly

• promoting commitment to equality.

The Parent of the Child with Special Educational Needs

Educational partner and trainer

Family education has in mind the building of skills, norms, values of life within the family and targets its members, encompassing a wider area than parental education. Duming, in the 1990s, 1994, defined family education as a complex of social activities carried out by parents, in the family space, aimed at children through the interventionists, and in the direction of parents, being parental training.

The specificity of the disabled child's family involves the role of the parent as a mediator between the special child, whose adaptation to interpersonal relationships is difficult, and the others, the belonging community, that is, strangers.

Often this mediation is done with a lot of subjectivity, so parents can overestimate inappropriate reactions from a stranger, misinterpret neutral gestures, can give the child a wrong perception of those around them, insist on the malice and hypocrisy of the people around them, by feeding him the belief that his deficiency is not accepted, that there is a lot of intolerance around him, I turn disability into disability by approaching social difficulties as a terminus, it prevents children from understanding and accepting all aspects related to their own disability precisely because they themselves did not accept the child's disability.

The role of the mediator takes on a major importance because the parents' reactions to the child's disability determine the child's reactions of accepting/approaching his disability.

The reactions of overprotection, acceptance, denial or rejection group parents into several categories, such as: balanced parents, exaggerated parents, indifferent parents, authoritarian (rigid) parents, inconsistent parents.

Parents of children with CES go through several phases of suffering until the moment of accepting the situation, which we mention next: anger, at oneself and at others, negotiation, with God or other higher powers and with oneself, depression, sadness and regret , fear and insecurity, but also acceptance, emotional detachment and the cessation of self-struggle as claimed by Elisabeth Kubler-Ross /Grief Cyrcle in material studied at https://www.flickr.com/photos/journeytogenius/accessed November 2019.

The family is the one that assumes responsibility for its members, society has the role of supporting it. The purpose of working with the family is to expand its competences through the conscious involvement of its intervention and responsibility.

Family engagement is essential because the family of the child with disabilities and/or other SEN will never be able to function or manage the situation on their own but need additional resources, information and support.

In the conditions of the inclusive school, the role of the parents as an educational partner involves several aspects, namely through direct participation in the life of the school, parents can exercise their influence on certain decision-making processes aimed at the educational course by imposing their point of view on the functioning of the school and have a concrete participation to the implementation of managerial functions in the school. Another aspect is the school's embrace of the idea of integration or inclusion, which also depends on the attitude of parents in relation to the child's educational problems, the absence or indifference of parents coming in opposition to this approach, not least the reluctant or distrustful position of parents regarding the life and educational development of a child with special educational needs (slower or faster changes) creates difficulties, erroneous representations/mentality do not develop positive attitudes.

Trust is the foundation of the link between family and school, proper communication ensures a mutual exchange of trust, Gherhuț (2006) mentioned.

The partnership involves the exchange of information, good practices, experiences, and for this communication to work, it is necessary to train/develop good active listening skills, to know how to listen, to be able to create some premises for collaboration.

For a more solid support of the inclusive school, the members of the students' families must comply with a minimum of requirements such as providing up-to-date information on their child regarding the preparation of homework, the style and manner of learning at home, his interests and the way he reacts in various situations, concerns, preferences/non-preferences, to take part in every school activity and to be active in the process of promoting various practices of educational integration of special children at all levels of social life.

Specific behavioral structures are imposed in order to accept and encourage the integration of people with special needs in their communities, who have the responsibility to provide support to teachers in choosing realistic strategy systems regarding the development and education of children, both in school and outside it through the provision of important information that helps to develop and implement the individualized curriculum for the child, the involvement in decision-making regarding the child and the continuous habilitation/rehabilitation programs of the child's development.

It is very important to accept without resentment the possible limitations implied by the level and difficulty of their deficiencies, but also to be sincere partners in a dialogue and to be open without any reservations about the collaboration with the team made up of specialists who have the task of educating and to make possible the recovery of the children, keeping under observation the evolution that they have presented to the children in different contexts in which life can bring them and to maintain a close relationship with the rest of the parents in the help group and to ensure that the personal experiences that they -have been with their own children in the activities that took place within the family are shared, and last but not least to be aware of the vast advantages that the inclusive school offers to special children to ensure that they will attend classes.

The inclusive school and all teachers have the responsibility to create an environment accessible to families in which both they and the special child can integrate, by mobilizing every family in which there are children with special educational requirements to take part in the established educational and therapeutic program , respecting the rights and grievances of families to opt for when, how and how much they can take part in therapeutic activities, respectively their continuation at home, but also ensuring that the exchange of information about the child takes place constantly with the family.

An important role is the location of the resources related to the educational and recuperative-therapeutic program intended for students with special needs,

through which the parents' effort can be supported, informing the family about the activities suggested by the recuperative-therapeutic program and its customization at the request of the parents, as well as bringing information to the family regarding any update appearing in the program, but also receiving the suggestions and impressions brought by the family and using them in order to improve the programs dedicated to students with educational requirements.

The partnership has a special role in the operation of the inclusive school, because within them the students are the main beneficiaries of the collaboration through which certain difficult situations can be anticipated and prevented, they contribute to the development of the educational and social skills of parents and other community actors and offer services and support families, ensures the facilitation of the exchange of ideas between the parties, gives birth to innovative ideas and contributes to the solution of certain problems.

The whole partnership facilitates the connection between the child and the family, between the families, the school staff and the community through the opportunity to actively participate in the educational experiences of the students.

Working in a team allows all the people involved in the education/development of the child with special educational requirements to satisfy the student's needs by identifying the student's strengths, interests and needs as clearly/precisely as possible and using the collected information and conclusions following the observation of the student's behavior for the purpose of individualizing the curriculum for it, but also the establishment of consensus regarding curriculum planning by correlating the general curriculum goals with the individualized goals established in the PEI.

Another advantage of teamwork is establishing consensus on the way and level of providing support services to the student by suggesting/recommending appropriate educational strategies/technologies, establishing the place where the support activity is carried out (in the classroom, in the resource room/offices), establishing other services available in the community.

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TECHNOLOGY OF ASSIMILATION OF MATERIALS FOR THE TEACHING UNIT "STATISTICS AND PROBABILITY" IN XI CLASSES OF GENERAL EDUCATION SCHOOLS

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Abstract

In the article, it is included in the content of Mathematics subject in XI classes of general education schools "Statistics and Probability" the content of the skills intended to become the subjects of the students in the process of teaching the materials for the educational unit was presented. Content elements that carry the "enabling function" in the formation of these skills "Statistics and Probability" attention is paid to their presence in the educational unit and to the technology of turning them into action in the students' cognition (adequate to the "movement-possibility-new quality" paradigm). "Statistics and Probability" "System-structure" of the transformed elements in the teaching unit based on the dialectical approach "Statistical indicators: dispersion and standard deviation", "Forms of data distribution. Normal distribution", "Box - handle diagram", "Random Events and Probability" it is considered appropriate to make it into a system on topics. It should be noted that the system of tasks (question, problem, study) that serves as a means of organizing and managing the educational process for mastering the content elements presented by the students should contain verbs that are required to be performed in the topics. Examples of tasks of that kind are included in the content of the work.

Keywords: probability; statistical indicators; random events; dispersion; standard deviation; information distribution forms; normal distribution; chart; box-handle diagram.

The actuality of the subject. There are no recommendations that are useful to be adopted for guidance in the teacher's activity in the currently used textbook complex [7-8] and various educational literature about the teaching units, basic standards, sub-standards, and defined topics in the subject of mathematics. These are very useful in terms of teaching the process of teaching mathematics according to the curriculum model. It is not denied that continuous improvement of the teaching process in the subject is logical, most didactic problems are eternal. Of course, as the experience of using the curriculum is formed, the methodical system (technology) of the teaching process adequate to it should also be improved. Based on this logic, ""Technology of mastering materials for the teaching unit "Statistics and Probability" in XI grades of general education schools"We claim the relevance of the research of the topic.

Interpretation of generalizations based on information obtained on the basis of research.

In order to clarify the logic of the presented scientific interpretation, let us note that in the summarization of the materials obtained on the research topic, in addition to referring to the forms and methods of scientific cognition, "training and teaching activity", "learning and mastering", "content and content line", " main standard with the expected result", "main standard and sub-standards", "system-whole-part-element relations" were focused [2].

Scientific sources indicate that "training" and "educational activity" are one of the main concepts of pedagogy. Although training is an important characteristic of educational activity, it does not cover all aspects of it. Training, in the broadest sense of the word, involves the acquisition of new knowledge, skills and habits. However, learning and learning activities are essentially different events. Appropriation is an integral part not only of the learning process, but of every field of activity [1;150].

The analysis of the materials obtained from scientific sources leads us to the conclusion that training is a way of implementing education, and the fact that spiritual learning, memorizing what has been learned, and acquiring the experience of creative activity based on it depends on the way of learning (the dialectic of the content and form of cognitive action). Formation of the educational space in didactics according to the associations of industrial revolutions and formation of the model of its implementation is an eternal problem [3].

Based on the idea of L.Bertalanfi to get to the essence of many pedagogical concepts, to give an honest scientific interpretation, in our opinion, it is a successful approach [9; 8]. By the way, let's emphasize that the "system-structural approach" is a developed branch of dialectics, which has gained an independent "status" since the 30s of the 20th century [5-6].

The technology of education implementation (methodology in the traditional approach) has its own system [10]. The expected result in the mentioned tech-

nological system is determined by the state of movement of the selected content. A technological system is available for each educational unit. It is not accidental that the selection of the teaching unit is brought to the center of attention in the design of the mentioned system [2-3].

The main and sub-content standards of the "Probability and statistics" section, expressed (called) in the form of the same name, contained in the "Statistics and probability" content line in the XI grades of the general education school, are: 5.1. Collects statistical data, systematizes, analyzes and presents the result; 5.1.1. Calculates the variance and mean square measure of the measurement; 5.2. Understands and applies basic concepts of probability theory; 5.2.1. It applies the normal distribution law to the calculation of the probability of the event [8;5].

"Statistics and Probability" in the process of teaching the topics covered in the educational unit, students are expected to become subjects of the following skills:

It presents the data according to statistical indicators that characterize the distribution, such as numerical mean, median, mode, central tendency, and the largest difference; It calculates the trend, variance, standard deviation according to the database given in various forms; Demonstrates an understanding of the relationship between the value of the standard deviation and the distribution of data values by showing examples; Constructs a normal distribution curve for the sample (population) and presents it according to the situation; A graph presents information according to the numerical mean and standard deviation in a normal distribution; Determines and presents data according to the conditions required in the normal distribution with calculations; Solves problems related to probability according to the normal distribution curve; Divides the data into quartiles; Presents data with a threaded box diagram; Demonstrates understanding of concepts such as random event, random event space, trial, event; Applies probabilities to the calculation of events that match and do not match the set; Apply the rule of multiplication of probabilities to the occurrence of independent events; Apply the conditional probability formula to problem solving;

Mastering the materials of this educational unit, students' active mathematical vocabulary includes the following concepts - population, selection, numerical mean, mode, median, tendency, mean square deviation, dispersion, box-handle diagram, event, random event, experiment, elementary event, elementary events space, allows to enrich it with independent events, dependent events, conditional probability and considerations related to them [8; 260].

It is recommended to take advantage of virtual tools (important links for teaching the course [11-17]) and various worksheets as additional resources in teaching the materials of the "Statistics and Probability" educational unit.

It is enough to devote 2 hours to the teaching of the subject "Statistical indicators: dispersion and standard deviation". At the beginning of the teaching of this topic, in order to master the concepts of "Dispersion" and "standard deviation", the necessary parts of the content of the teaching materials about "numerical mean", "mode", "median" used in analyzing statistical data are reproduced. For this purpose, it is recommended to benefit from the application of reproductive studies and heuristic methods. Students remember that they used "numerical mean", "mode", and "median" indicators to analyze statistical data. They know that: the numerical mean is found using the values of all the data, and deviations can lead to wrong conclusions about the population as they affect its value. Median is the middle value of data arranged in ascending order. The median divides the data into two halves—lower and upper halves. It is a more reliable statistic when outliers exist and is useful for analyzing a limited amount of data. The mode defines characteristic information for the population, which allows us to think about the numerical mean, and is more convenient for the analysis of categorical data (gender, color, etc.). Data can have more than one mode or no mode [7; 261].

Summarizing the restorative activities of the students, the teacher informs them that in order to draw more correct conclusions based on statistical data, indicators such as tendency, dispersion, and standard deviation are used to characterize them. The bias is the difference between the data value and the numerical mean $x_{bias} = x - \overline{x}$, where x the given numerical value of the data, $\bar{x}$ is the numerical average. Dispersion is the ratio of the sum of the squares of the trends to the number of data values and is denoted by σ^2 and $\sigma^2 = \frac{\sum(x-\bar{x})^2}{n}$, where n is the number of data values. The standard deviation is called the square root of the variance and is usually denoted by the letter: $\sigma -$ sigma: . $\sigma = \sqrt{\sigma^2}$. The standard deviation is an important statistic that characterizes the distribution of data. The standard deviation shows the distribution of data values according to the numerical mean, and the farther apart the data values are, the greater the standard deviation. The closer the data values are to each other, the smaller the standard deviation. In other words, if the data is concentrated around the numerical mean, the standard deviation is small.

The teacher should use these tasks in order to regulate the environment for deeper assimilation of this information given to the students. This is an approach tested by practitioners, its effectiveness is not in doubt. The following can be included among such examples [7; 261-263].

Example. The weekly salary of 10 randomly selected employees in the company is as follows: 120, 160, 90, 175, 110, 80, 220, 150, 300, 95 manats. Calculate the mean, variance, and standard deviation for this data and explain the situation.

Solution:

1. Let's make a table according to the salaries.

2. Let's calculate the numerical mean:$\bar{x} = 1400 : 10 = 140$.

3. By subtracting the numerical average from each salary amount, its deviation from the numerical average is found.

For example, $120 - 140 = -20$, this person's salary is 20 manat less than the average weekly salary. Let's add a column to the table showing the trend ($x_i -$

$\bar{x}$) for each salary. The trends of the individual data sum to zero. This is always the case and does not provide new information. Therefore, the sum of the squares of the trends is used.

4. Let's calculate each $(x_i - \bar{x})^2$ - and record it in a new column in the table and find the sum: $\sum(x_i - \bar{x})^2$

$$\sum(x_i - \bar{x})^2 = 43150.$$

To calculate the variance, divide the sum we find by the number of data n ($n = 10$):

$$\sigma^2 = \frac{\sum(x_i - \bar{x})^2}{n} = \frac{43150}{10} = 4315.$$

Numerical average $\bar{x} = \frac{\sum x_i}{n} = 140$

Salary	Tendency: $(x_1 - \bar{x})$	Square: $(x_1 - \bar{x})^2$
120	-20	400
160	20	400
90	-50	2500
175	35	1225
110	-30	900
80	-60	3600
220	80	6400
150	10	100
300	160	25600
95	-45	2025
Total: $\sum x_i = 1400$	Total: $\sum(x_i - \bar{x}) = 0$	Total: $\sum(x_i - \bar{x})^2$

5. To find the standard deviation of wages, take the square root of the variance: $\sigma = \sqrt{\sigma^2} = \sqrt{4315} \approx 65{,}69$

It is explained to the students that the change in wages can be estimated according to the standard deviation. For example, a person earning 300 manat earns more than 2 standard deviations (2×65) more than the average weekly salary (140 manat). A person who receives a weekly salary of 90 manats is paid approximately one standard deviation (65) less than the weekly salary.

Continuing the teaching process, at this point it would be useful to bring to the students' attention an example of finding the standard deviation of grouped data.

*Example.*The number of students who missed daily lessons in a class for 50 days is given. Calculate the standard deviation.

Solution:

1.First, let's group the data according to the number of students who missed classes daily and record it in the frequency table. For example, the number of days that no one misses class is 10, the number of days that 1 student misses class is 19, etc.

The number of students who missed daily lessons in a class during 50 days

1	3	1	1	1	1
5	0	1	2	2	1
0	1	1	0	0	0
3	6	2	3	0	1
1	3	0	3	1	1
1	1	6	0	1	3
4	1	1	6	6	1
2	2	2	0	3	0
2	4				

2. Let's find the numerical mean according to the information we received from the table.

$$\bar{x} = \frac{\sum x \cdot f}{n} = \frac{91}{50} \approx 1{,}8.$$

3. The trend of each data: a) is found from the numerical average value: $(x_i - \bar{x})$; b) squared: $(x_i - \bar{x})^2$; c) the obtained result is multiplied by the number n, added and divided to get the square root.

x_i	f_i	$x_i f_i$
0	10	0
1	19	19
2	7	14
3	7	21
4	2	8
5	1	5
6	4	24
	$\Sigma = 50$	$\Sigma = 91$

$x_i - \bar{x}$	$(x_i - \bar{x})^2$	$(x_i - \bar{x})^2 f_i$
-1.8	3.24	32,40
-0.8	0.64	12,16
0.2	0.04	0.28
1,2	1.44	10.08
2.2	4.84	9.68
3.2	10,24	10.2470.56
4.2	17.64	

$$\sigma = \sqrt{\frac{\sum(x_i - \bar{x})^2 f_i}{n}} = \sqrt{\frac{145{,}4}{50}} \approx 1{,}71$$

As it can be seen, the number of children who do not come to class daily is 1.71 with a standard deviation and an average of 1.8 [6; 172-175].

It is recommended to apply a system of tasks made into a special system for students to master the theoretical materials related to the topic "Statistics: dispersion and standard deviation", to include them in the existing practice base and to develop the relevant skills in students..We consider it expedient to include the following task examples in the mentioned system.

1.Complete the tasks according to the given information.

100; 200; 300; 400; 500; 600; 700; 800; 900; 1000.

a) Find the numerical mean ($\bar{x}$) and standard deviation (σ);

b) Multiply the value of each data by 10. Find the mean ($\bar{x}$) and standard deviation (σ) for the new data.

c) Divide the price of each item by 10. Find $\bar{x}$ and σ.

d) Discuss your thoughts on the results. Explain whether the numerical mean is the correct indicator for assessing the condition of the value of the standard deviation.

2. The results of 8 girls and 8 boys randomly selected from among the SAT (Scholastic Aptitude Test) test takers are as follows.

Boys' SAT scores: 1059; 1328; 1175; 1123; 923; 1017; 1214; 1042.

Girls' SAT scores: 1226; 965; 841; 1053; 1056; 1393; 1312; 1222.

a) Find the largest variance, variance, and standard deviation for each group of data.

b) Explain the result according to the real situation.

3. Find the largest variance, mean, variance, and standard deviation that fit the data.

*a)*11; 10; 11; 7; 8; 11; 6; 4; 6; 7

*b)*13; 15; 13; 17; 18; 13; 15; 14; 13; 20; 20; 18; 23; 20 and so on.

"Forms of information distribution. Normal distribution" it is considered acceptable to allocate 2 lesson hours to the teaching of the subject. It is recommended to provide the students with information in the following content.

The students are told that according to the shape of the frequency distribution, the appropriate graphic shapes (histogram or frequency polygon) can be symmetrical or asymmetrical:

1. Normal distribution; 2. Right-skewed distribution (positive distribution); 3. Left-skewed distribution (negative distribution).

We can say about the normal distribution: The normal distribution curve is symmetrical with respect to the numerical mean: In the normal distribution, the numerical mean, median, and mode are equal; The graph of the normal distribution is constructed according to the numerical mean $\bar{x}$ and standard deviation σ. "The normal distribution" basically reflects the data around three standard deviations [8; 266].)

Students should know that the graph of a normal distribution shifts to the right or to the left depending on the value of the numerical mean. The graph is compressed or stretched by changing the standard deviation at the same value of the numerical mean.

In the process of teaching the subject, it is important to involve students in the activities of systemized learning tasks, and the normal distribution form should be mastered by them.

First, in order to visualize the form of normal distribution, students' involvement in the following example leads to effective results.

Example. In a normal distribution corresponding to any population X, the numerical mean is 40 and the standard deviation is 5. What percentage of grades included in this collection: a) is less than 45? b) is between 30 and 45 [8; 267].

After the implementation of the example, it is useful to continue the process of teaching the subject by engaging the students in several learning tasks as follows.

1. It is known that the numerical mean is 72 (points) and the standard deviation is 6 (points) in the normal distribution corresponding to the test.

1) Write the following information: a) those located around 1 standard deviation from the numerical mean;

b) those located around 2 standard deviations from the numerical mean; c) those located around 3 standard deviations from the numerical mean.

2) Draw a curve corresponding to a normal distribution. Show each interval as a percentage.

2. Plot the normal distribution curves in the same coordinate system. Explain the similarities and differences between these graphs.

a) numerical mean 50 percent, standard deviation 10

numerical mean 50 percent, standard deviation 20

b) numerical mean 50 percent, standard deviation 5

numerical mean 40 percent, standard deviation 5.

3. The test results were presented with a normal distribution. According to the results, the numerical average is 70, the standard deviation is 4.5. 360 people participated in the exam.

1) If a random person is chosen, the probability that he/she: a) is among those who scored in the interval of 65-80; b) the possibility of being among those who scored not less than 75 points; c) Find the probability that he is among those who scored less than 62. 2) Calculate the range in which 90% of test takers score, etc.

"Box - Handle Diagram"it is enough to allocate 2 lesson hours to the teaching of the subject. How to construct a box-handle diagram can be explained to the students on the following example.

Example. Scores of 15 employees of the company during the safety standards exam was like: 13; 9; 18; 15; 14; 21; 7; 10; 11; 20; 5; 18; 37; 16; 17. Present this information with a box-and-handle diagram.

1. By arranging the data in ascending order, the median is determined and denoted by Q_2 ($Q_2 = 15$);

2. Data to the left of the median form the lower half, and data to the right form the upper half. That is, the median divides the data into two halves.

3. The medians of the halves, called quartiles (here, divides the data into 4 parts. $Q_1 = 10, Q_3 = 18$)

4. Interquartile variation is determined: $Q_3 - Q_1 = 18 - 10 = 8$.

5. The smallest and largest values of the information given on the number axis, the values of the quartiles and the median - 5 important points are noted. A rectangle is drawn whose length is equal to the interquartile range. This rectangle is divided into two parts by the median. Then, by combining the corresponding quartiles with the largest and smallest values, the handles of the box are drawn (the steps performed in the process should be visually accompanied, otherwise the steps taken may be difficult for students to understand) [4; 452-453].

Thus, a box-handle diagram is constructed according to the given data. According to the diagram, the data is presented as follows: in about half of the 15 people, 50% of the participants scored between 10 and 18. 25% scored less than 10, 25% scored more than 10. The difference in the length of the left and right handle depends on the difference in the values of the information in the corresponding part.

Note that the activity on the sample should be generalized.

When building a box-handle diagram, 5 pieces of information are determined according to the given population: median-Q_2, median-quartile Q_1 of the lower part where the data smaller than the median is collected, median-quartile of the upper part where the data is greater than the median is collected, the smallest value and the largest value.

Steps to construct a box-and-handle diagram:

1. A horizontal straight line is drawn;

2. Divisions with a certain scale are set according to the data change range;

3. The 5 specified data - Q_1 , Q_2, Q_3, the smallest value, the largest value - are recorded on a straight line;

4. A box is drawn up Q_1 to Q_3;

5. Handles are drawn from the smallest price Q_1 to the largest price Q_3.

Students are engaged in cognitive activity on another example, as followslays the foundation for a more sophisticated mastery of the steps of constructing a box-and-handle diagram.

Example. The ages of the members of the Paralympic women's volleyball team are as follows: 24; 30; 30; 22; 25; 22; 18; 25; 28; 30; 25; 27. Present the data with a box-handle diagram.

"Box-handle diagram", it is recommended to master the building steps by the students, to include them in the existing experience base and to apply a system of tasks made into a special system for the development of the relevant skills in the students.

"Random Events and Probability" it is enough to devote 4 hours of study to the subject. On the topic "Random events and probability". students are given information in the following content.

It is explained to them that the branch of mathematics that studies the regularity of random events is called probability theory. This theory studies not individual events, but the results of many experiments, that is, regularities of massive random events. Probability is a mathematical-numerical characteristic of the possibility of a certain event occurring under certain conditions.

A probable event is certain to occur as a result of experiment, experiment, or observation, and an impossible event never occurs. Events are conventionally interpreted as complex (separable) and elementary (nonseparable) events. Each inseparable result of an experiment, experiment or observation is called an elementary event. The set of all elementary events is called the space of eleme ntary events or test space. All possible outcomes of a particular experiment or observation $E_1, E_2, \ldots E_n$ the space of elementary events if it has elementary events $U = \{E_1, \ldots . E_n\}$ can to any subset of the space of elementary events***is called an "event".*** ***This time*** the empty set ***(***Ø) impossible event, U and it will probably be an event. Since each event is a subset of the space of elementary events, actions assigned to sets are assigned to events in the same way [4; 455-458]:

- An event whose outcomes are all included in at least one of events A or B is called a combination of events A and B and is denoted by A∪B.
- An event whose outcomes include both event A and event B is called the intersection of events A and B and is denoted as A∩B.
- Events that do not have common outcomes are called incompatible events.
- The set of all outcomes not included in event A is called the counter event of event A and is denoted as $\bar{A}$.
- If every consequence of event A is also a consequence of event B, event A is said to cause event B, or event B is a consequence of event A, and this fact is written as A⊂ B.
- An event whose results are not included in event B, but only included in event A, is called the difference between event A and event B. Denoted as A\B.

In the course of teaching the subject in the series of trials of the event ***frequency*** is introduced to the concept. They understand that if we denote the total number of trials by *n* and the number of trials in which event *A* occurs during *n* trials by n(A), the $\frac{n(A)}{n}$ ratio is called the frequency of event *A* in this series of trials. The probability of a random event can be approximated by the frequency of a series of multiple trials: $P(A) \approx \frac{n(A)}{n}$; The probability *P(A)* does not depend on whether the test is passed or not, this number characterizes the random event *A*. The probability of a random event is the number to which the values of the observed frequency converge during numerous trials. Such a definition of probability is called a statistical definition. It should be clear to the students that the elementary events of the test occurring under the same conditions and under the same conditions are called equal opportunity events if one has no advantage over the other. The ratio of the number of favorable outcomes for event *A* to the number of all equally likely events is called the probability of event *A* and is denoted by *P(A)*: $P(A) = \frac{n(A)}{n}$ (1). This definition is

called the classical definition of the probability of an event. $0 \le n(A) \le n$ since it follows from formula (1) that $0 \le P(A) \le 1; E_1, E_2, ...E_n$ if all events are favorable to event *A*, i.e. if *n(A)=n*, then $P(A) = \frac{n}{n} = 1$

Probably the probability of the event is equal to 1. If neither outcome is favorable to event *A*, that is, if *A* is an impossible event, then n(A)=0 and P(A)=0. The probability of an impossible event is zero. Here it is useful to bring the following property to the attention of students.

Property. Equally possible $E_1, ...E_n$ elementary events have the same probability and the sum of these probabilities is equal to 1.

Indeed, suppose event $A\, E_1, ...E_n$ coincides with one of the events, e.g. $A = E_1$ is Then $E_i \cap E_j = Ø$ since $i \ne 1$ when $A \ne E_i$ happens. So, $n(A) = n(E_1) = 1.$ According to formula (1) $P(A) = P(E_1) = \frac{1}{n}$.

A similar rule shows that $P(E_2) = \frac{1}{n}, ..., P(E_n) = \frac{1}{n}$; From here it follows that $P(E_1) + P(E_2) + \cdots + P(E_n) = 1$

The given theoretical information should be clarified by special studies. For this purpose, the following examples can be used:

1. There are 10 white and 15 black balls in a box. Find the probability that a ball drawn at random is black.

2. There are 10 white and 15 black balls in a box. Taking a ball out of the box and suppose that the ball is black. Let's put it aside and take a ball out of the box. Let's find the probability that this ball is also black.

3. There are 10 white and 15 black balls in a box. Two balls are drawn from the box at a time. Find the probability that both balls are black.

4. There are 7 white, 5 red, and 8 yellow balls in the box. Let us denote the event of a drawn ball being white by A, the event that it is red by Q, and the event that it is yellow by S, and find the probability of each of these events.

5. A coin is tossed twice. In both cases, you have to find the probability that the face with the coat of arms falls.

6. While inspecting a batch of 200 identical parts, the technical control department discovered 6 non-standard parts. Let's find the probability that a detail drawn at random is not standard.

7. The probability of hitting a target with pistol fire is 0.75. If 200 shots are fired, how many bullets can be expected to hit the target?

Students should know that they calculate the probability of a complex event by dividing it into events with known probabilities. As is known, $U = \{E_1, ...E_n\}$ each of the space of elementary events E_k element is called its probability and is not negative $P(E_k)$ numerically opposed that $\sum_{k=1}^{n} P(E_k) = P(E_1) + ... + P(E_n) = 1$ condition is paid. Then, U - or probability space is called. Probability space $(E_1, ..., E_n; P_1, ... P_n)$ or (UiP) is marked as It follows that for every k $0 \le P(E_k); k = 1,2, ...n$

Since each event *A* is a certain subset of the space of elementary events, it has a separation over elementary events, that is, a certain E_{k_p} for elementary phenomena $A = \underset{P}{U}\, E_{k_P}$ happens. The probability P(A) of the event A is the sum of the probabilities of the elementary events in its division by elementary events. $P(A) = P\left(\underset{P}{U}\, E_{k_P}\right) = \sum_{P} P(E_{k_P})$

It is useful to familiarize students with the following theorems, which play an important role in probability theory.

Theorem 1. a) any anesthetic $A \subset U$ and $B \subset U$ for events $P(A \cup B) = P(A) + P(B)$; b) $P(Ø) = 0$; c) $A \subset U$, $B \subset U$ and $A \subset B$ for any events A and B satisfying their relations $P(A) \le P(B)$; c) any $A \subset U$ the same is paid for the event and its opposite event; d) any $\bar{A} P(A) = 1 - P(A)$ $A \subset U$ and $B \subset U$ for events $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ attitude is correct.

The property of the theorem in clause a) can be summarized as follows: pairwise disjoint $A_1, A_2, ...A_n$ the probability of the combination of events is equal to the sum of their probabilities, that is, $i \ne j$ when $A_i \cap A_j =$ Ø while $P\left(\bigcup_{i=1}^{n} A_i\right) = \sum_{i=1}^{n} P(A_i)$. This property is called the property of summation of probabilities.

- B is a positive probability event and A is any event $P(A|B) = \frac{P(A \cap B)}{P(B)}$

the quantity is called the conditional probability of the event A under the condition of occurrence of the event B. It follows that $P(A \cap B) = P(A) \cdot P(B \setminus A)$

This property is called the property of multiplication of probabilities.

Theorem 2. U is a space of elementary events with equal possibilities. Certain $B \subset U$ any within the condition of occurrence of the event $A \subset U$ conditional probability of an event $P(A|B) = \frac{n(A \cap B)}{n(B)}$ is found by the formula

Theorem 3. U the space of elementary phenomena is not matched in pairs $B_1,....B_n$ separated by events, namely: $U = B_1 \cup .....\cup B_n$ and $i \neq j$ for $B_i \cap B_j = \emptyset$. Then, for any event A

$$P(A) = \sum_{i=1}^{n} P(A|B_i)P(B_i) = P(A|B_1)\cdot P(B_1) + ...+ P(A|B_n)\cdot P(B_n)$$

formula is correct. This formula is called the complete probability formula.

- $0 < P(B) < 1$ when

$$P(A) = P(A|B)\cdot P(B) + P(A|\overline{B})\cdot P(\overline{B}).$$

In order to achieve the expected result in the process of teaching the subject, students should be familiar with the concept of independent events. They are informed by the following information.

Suppose that A and B are two different nonempty events of the space of elementary events. If the occurrence of event A does not depend on the occurrence of event B,

$P(A|B) = P(A)$ we can write (assuming that $P(B) > 0$). Then the conditional probability

$P(A|B) = \dfrac{P(A\cap B)}{P(B)}$ from the formula we get that $P(A\cap B) = P(B)\cdot P(B)$

- *Events A and B* $P(A\cap B) = P(B)\cdot P(B)$

when they satisfy the relation they are called independent events.

It should be noted here that this definition $P(B) = 0$ in the case, that is $P(A|B)$ is true even if the conditional probability is not specified.

- If events A and B are independent, known $P(A\cup B) = P(A) + P(B) - P(A\cap B)$ the formula $P(A\cup B) = P(A) + P(B) - P(A)\cdot P(B)$ can be written as

Any $k = 1,.....n$ and $i \le i_1 < i_2 < ...i_k \le n$ for

$P(A_{i_1} \cap .....\cap A_{i_k}) = P(A_{i_1})\cdot .....(P(A_{i_n})$

when paid $A_1,.....A_n$ a system of events is called a system that is independent of the totality.

$A_1,.....A_n$ in the case of a system that is independent of the whole, in the special case, $P(A_1 \cap .....\cap A_n) = P(A_1)\cdot ...\cdot (P(A_n)$ the probability multiplication formula is obtained.

As is known, according to the classical definition of probability, to find the probability of event *A* in a given problem, it is enough to divide the number of elements of A (the number of "favorable cases") by the total number of elements appearing in the considered problem (the number of "possible cases"). Finding the number of favorable and feasible cases when looking at phenomena with finite element results is, in many cases, possible through the application of combination theory. In this direction, a task system should be applied for the purpose of forming students' skills. The following can be used as an example [6; 195-196].

1. There are 9 rows in the auditorium of the cinema, and 9 seats in each row. The audience takes a random seat. Is it more likely that the sum of the numbers of the row and the place in the row is even or odd? (the sum is even more likely)

2. (Selection by return). The box contains a numbered ball. Once a ball is randomly removed from the box, its number is noted and it is returned to the box. Find the probability of the event that all elements of the sample are different.$1,2,.....n$ nk

$$(P(B) = \frac{n(B)}{n(U)} = \frac{A_n^k}{n^k})$$

3. There is a sphere numbered with numbers in the box. The spheres are carefully mixed and removed from the box one by one. Find the probability that the balls come out in the numbered sequence.$1,2,.....nn1,2,.....n\left(P = \dfrac{1}{P_n} = \dfrac{1}{n!}\right)$

4. There is a ball of the same shape in the box.nTheir number is red, the rest$k$and it is the sky. M balls are randomly drawn from the box $(m \le n)$. Find the probability that the ball is red among the selected m balls$l$ $(l < m)$. $\left(P = \dfrac{C_k^l \cdot C_{n-k}^{m-l}}{C_n^m}\right)$

5. They threw a point inside the Egyptian triangle. Find the probability that the point is at a distance greater than 1 from the sides of the triangle.

Note that these types of problems are also called geometric probability problems, and the object thrown into a certain area is located in this area$D$ $G \subset D$ the ratio of the size of the area (length, area, volume) to the size of the area is taken as the probability of the event falling into the area. The answer to this task:GD

$$P = \frac{6 - \dfrac{\pi}{2}}{6} = 1 - \frac{\pi}{12}$$ is

"Statistics and Probability"it is recommended to use the summative assessment criteria listed below.

1. Presents data according to statistical indicators that characterize the distribution, such as the numerical mean, median, mode, central tendency, and the largest difference; 2. Calculates the trend, dispersion, standard deviation according to the database given in various forms; 3. Constructs a normal distribution curve according to the selection (population) and presents it according to the situation; 4. Determines and presents data according to the conditions required in normal distribution with calculations; 5. Presents information

with a box-handle diagram; 6. Demonstrates understanding of concepts such as trial, event, space of elementary events, random event; 7. Applies the rule of adding probabilities to the calculation of probabilities of events; 8. Applies the rule of multiplying probabilities to calculating the probabilities of independent events; 9. Solves problems related to conditional probabilities [4; 459-460].

*The result.*1)"Statistics and Probability"in the process of teaching the topics covered in the educational unit, the selection and application of task types should be focused on in order for students to become subjects of the verbs based on the expected results; 2)"Statistics and Probability"the inclusion of necessary terms in the content of students' active mathematical vocabulary in the process of teaching materials for the educational unit should be considered as an important didactic requirement; 3)"Statistics and Probability"it is advisable to take advantage of virtual tools (important links for teaching the course) and various worksheets as an additional resource in teaching the materials of the educational unit; 4)"Statistics and Probability"Since the materials of the educational unit belong to the "Geometry" content line, in the real pedagogical process dialectic unity (the system- structure' approach; whole-part relations) should be expected; 5) Expectation of the "opportunity-movement-quality" paradigm in the selection of tasks and their systematization has a positive effect on the efficiency of the educational process.

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POSSIBILITIES OF USING ELEMENTS OF ROBOTICS IN TEACHING PHYSICS: INTERDISCIPLINARY CONTINUITY IN STEM EDUCATION

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Abstract

The STEM direction is of great importance in the modern education system, as it is aimed at preparing students for the modern job market, developing creativity and critical thinking skills. The integration of physics and computer science disciplines, in particular the elements of robotics in physics, plays an important role in educational programs. Mastering both areas for schoolchildren and students will contribute to their success in research and engineering work in the future. The purpose of this study is to make it easier for students to understand complex physical concepts and increase their interest through the use of robotics in teaching physics, the effective implementation of the continuity of STEM disciplines. In the course of the study, an analysis was carried out on scientific publications in reliable sources based on the method of qualitative design, pedagogical control works based on qualitative research in the educational process. The use of elements of robotics in teaching physics made it possible to make the learning process interactive and practical. This research has been/was/is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP22784343).

Keywords: STEM education, STEM project learning, interdisciplinary continuity, robotics.

Introduction

The use of STEM Technologies prepares students to be successful in the technological and scientific fields in the future. The relationship between STEM and robotics allows for a comprehensive education for students. Robotics combines all aspects of STEM education and allows students to acquire skills that will be used in real life. This method develops students ' critical thinking, problem solving, and technical skills, as well as contributes to their success in the future. Through the connection of STEM and robotics, students apply theoretical knowledge in practice and understand the relationship between science and technology.

Domestic scientists D.Boyarinov, A.E.Samarina considered the potential of educational robotics in teacher training. The authors noted the importance of integrating innovative technologies into the educational process to improve the quality of Education. Organizational and pedagogical conditions for the training of students of pedagogical specialties in the field of educational robotics based on the multiplatform principle make it possible to personalize and activate the educational process of the future robotics teacher [1].

The theoretical and practical aspects of the use of robotics for education in teaching school-age children can be traced in the works of several scientists. R.F.Zúñiga Muñoz et al considers the methodology of the childprogramming method for teaching and educational robotics regulation. The authors emphasize the importance of effective methods of teaching programming for children, especially in the context of educational robotics. ChildProgramming is a way to learn programming aimed at Children. It involves the use of intuitive and interactive methods that contribute to a better understanding and assimilation of the material [2].

The potential for the formation of students ' creativity with the help of robotics is determined by foreign scientists B. Hendrik et al consider. The authors have developed a model of figured creativity based on the concept of learning through robotics. The model developed by the researchers includes the following structural components: problems of assembling robots, the use of creative methods for solving problems and assessing the creativity of students. The model developed by the authors has shown its effectiveness, offering a new approach to integrating technology into the educational process. The authors emphasize the need for additional research in this area to improve educational experience [3].

Although there are many advantages to using robotics in teaching physics, various problems can arise during its implementation. To solve these problems, it is important to provide financial support, improve the skills of teachers, make the curriculum more effective, provide technical support, comply with security measures and apply individual teaching methods. Through the implementation of these measures, robotics can be effectively used in teaching physics.

Research methods

The study used a design method (DBR) aimed at developing solutions used in specific educational environments and testing them in practice. This method is iterative in nature, that is, research and design go

through several cycles, and changes are made in each cycle based on the results obtained. The DBR method allows you to put theoretical knowledge into practice and develop a theory based on practical results. The design method is an innovative and integrative method aimed at solving problems in the field of Education. This method ensures a combination of theory and practice and helps to develop effective interventions aimed at improving the education system. Through the DBR method, researchers develop comprehensive and effective solutions aimed at solving specific problems, test and improve them in practice [4].

Also, methods for analyzing reliable articles were used to ensure the accuracy and objectivity of information.

Results and analyzes

From the results of the analysis of the literature, it can be seen that STEM interdisciplinary continuity aims to develop the ability to think comprehensively, acquire practical skills, develop innovative thinking, and improve professional training. Students are formed the ability to see the relationship between different disciplines and solve complex problems, practical skills that can be applied in real life, the desire to make discoveries, implement new ideas, and readiness for work in technological and scientific fields that will be needed in the future.

STEM continuity in teaching individual subjects of physics allows students to demonstrate the relationship between the fields of Science, Technology, Engineering and mathematics and master them in a comprehensive manner. The following are the main aspects and examples of STEM continuity in teaching individual physics disciplines (Table 1).

Table 1.

STEM continuity in teaching individual physics disciplines

Subject Of Physics	**Science**	**Technology**	**Engineering**	**Mathematics**
1	**2**	**3**	**4**	**5**
Mechanics	Experiments: study of the movement of bodies and the influence of forces.	Measurement and analysis of movement using sensors (for example, accelerometer).	Assembly of robots and mechanisms and control of their movement.	Solving equations of motion, constructing graphs and analyzing data.
Heat and thermodynamics	Experiments to study thermal phenomena (thermal conductivity, convection).	The use of temperature sensors and thermal imaging.	Design and analysis of heating systems.	Mathematical description and calculation of thermodynamic processes.
Electricity and magnetism	Study of the properties of electric and magnetic fields.	Assembly and analysis of electrical circuits (Arduino, Raspberry Pi).	Design and manufacture of electrical devices.	Construction and calculation of a mathematical model of electrical circuits.
Optics	Conducting experiments on the refraction, reflection and dispersion of light.	The use of lasers and optical instruments.	Design and assembly of optical systems.	Mathematical description of the distribution of light.

STEM technologies allow students to test and understand physical theories in practice. Through tools such as Arduino and Lego robotics, for example, students can explore physical laws through specific examples. This method demonstrates the practical application of theoretical knowledge and increases students ' interest in the educational process. STEM technologies make the learning process interactive and visual. For example, simulations and virtual laboratories allow you to visualize physical phenomena (Figure 1). This makes it easier for students to understand complex concepts and promotes better assimilation of educational material.

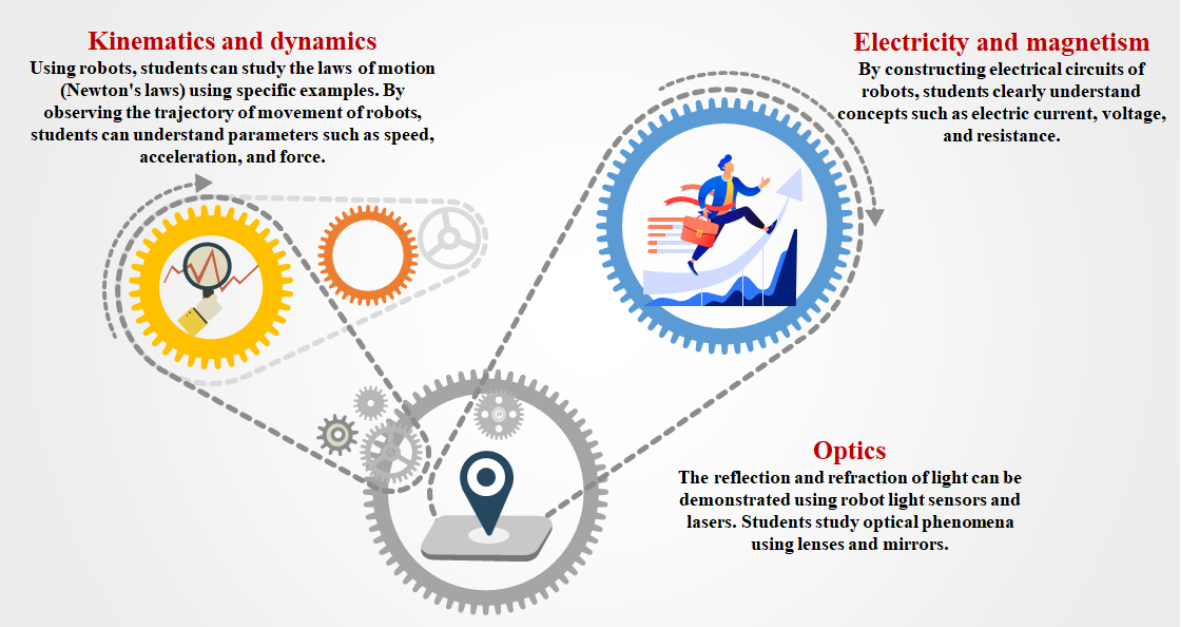

Figure 1. Continuity between the STEM industry

In teaching the topic of movement of mechanics in a circle, you can demonstrate specific laws of motion using Lego robots. This helps students visualize their theoretical knowledge. Students themselves will be able to design and program robots, track their movements and analyze the results (Figure 2).

Students observe the movement of robots and conduct experiments, changing different parameters:

- Change the radius of the circle;
- Changing the speed of the robot;
- Calculation and control of the centripetal force.

Students collect data from each experiment and analyze the dependence of angular velocity and acceleration on the radius of the circle, the change in the centripetal force and its effect on the movement of the robot. Students also draw conclusions based on the results obtained, compare theoretical knowledge and practical results, and identify errors and their causes.

Figure 2. Possibilities of using elements of robotics in the educational process

In addition, the use of the Arduino platform in teaching solar panels, as we can see in Figure 2, is an effective way to give students an idea of renewable energy sources and their operating principles. Through the Arduino platform, students learn to explore and operate solar panels, making the learning process interactive and experiential. The Arduino platform plays a fundamental role in the assembly and control of robots. It combines all the components of the robot and ensures that they work.

Students connect the solar panel to the Arduino platform and get acquainted with the necessary tools to monitor its operation, such as a solar panel, voltage and current sensors, light sensors (for example, LDR - a light-dependent resistor). Students write code in the Arduino IDE programming environment and develop programming skills to control solar panel operation and collect data (Write a code to measure the voltage and current of the solar panel. Changing the angle of the solar panel through light sensors and finding the most advantageous position).

M. Kandlhofer examines the possibilities of robotics in the process of teaching gifted students in high school on the example of MINT-Robo, which aims to develop skills in the field of Science, Technology, Engineering and Mathematics (STEM). Conducted in the form of interactive seminars, laboratory work and practical classes aimed at developing and programming educational robots. As a result of the study, students participating in the MINT-Robo project show a significant

improvement in academic performance and motivation for STEM education [5].

Arduino Robotics projects help students understand the basics of programming and electronics. This educational method allows students to acquire practical skills:

STEM education - Arduino Robotics is used in teaching STEM subjects (science, technology, engineering, mathematics);

Experimental laboratories - allows students to develop practical projects and explore them through the Arduino platform.

Therefore, the connection between Arduino and robotics will help students master the skills of assembling and programming robots. This method allows you to develop the technical and creative abilities of students, as well as deepen their knowledge in the fields of Science, Technology, Engineering and mathematics (STEM).

Conclusion

Teaching movement in a circle using Lego robotics allows students to understand physical concepts in practice and apply them in practice. This method can increase students ' interest and help them develop creativity, critical thinking, and technical skills.

Teaching solar panels using the Arduino platform helps students understand renewable energy sources and their operating principles. This method allows students to develop practical, programming and creativity skills, and also encourages them to pay attention to the issues of efficient energy use and Environmental Protection.

The relationship between Arduino and robotics is very close, as the Arduino platform is widely used to control and program various components of robots. The Arduino microcontroller establishes a connection between the sensors, motors and other devices of the robots, ensuring that they work in harmony.

The interdisciplinary continuity of STEM in physics contributed to the comprehensive development of students, their acquisition of scientific and technical skills, as well as future professional training. This method made the learning process interesting, interactive and productive.

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PHILOLOGICAL SCIENCES

"ANAMIN KİTABI" ƏSƏRİNDƏ GÜLBAHAR OBRAZI MİLLİ DİRÇƏLİŞİN SİMVOLU KİMİ

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THE IMAGE OF GULBAHAR AS A SYMBOL OF NATIONAL REVIVAL IN THE WORK "THE BOOK OF MOTHER"

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Annotasiya

Məqalədə dahi C.Məmmədquluzadənin "Anamın kitabı" dramında Gülbahar surətinin səciyyəvi xüsusiyyətləri təhlil edilir, müəllifin bu obraz vasitəsilə vermək istədiyi siqnallara işıq salınır. Bildirilir ki, əsərin baş qəhrəmanı Zəhra bəyim ana Vətəni, oğlanları Rüstəm, Mirzə Məhəmmədəli və Səməd Vahid birləşmək əvəzinə ayr-ayrı ölkələrə meyl edən, cəmiyyəti parçalayan ziyalıları, Gülbahar Azərbaycanın gələcəyini ifadə edirlər. Əsas surət Ana obrazı olsa da, məqalədə Azərbaycan cəmiyyətinin gələcək konturlarını özündə cəmləşdirən Gülbahar surəti əsas qəhrəmandan heç də geri qalmadığı göstərilir.

Abctract

The article analyzes the characteristic features of Gulbahar in the drama "My Mother's Book" by genius C. Mammadguluzadeh, and sheds light on the signals the author wants to give through this image. It is said that the main character of the work Zahrabeyim Motherland, his sons Rustam, Mirza Mahammadali and Samad Vahid, intellectuals who tend to separate countries and divide the society instead of uniting, Gulbahar express the future of Azerbaijan. Although the main image is the image of Ana, the article shows that the image of Gulbahar, which includes the future contours of Azerbaijani society, is not far behind the main hero.

Açar sözlər: "Anamın kitabı", *Zəhra bəyim ana, Gülbahar, Vətən.*

Keywords: "My Mother's Book", *Zahrabeyim mother, Gulbahar, homeland.*

Görkəmli Azərbaycan yazıçısı, naşiri, dramaturqu və publisisti Cəlil Məmmədquluzadənin yaratdığı əsərlərin başlıca leytmotivini vətən, xalq sevgisi təşkil edir. Ədibin "Anamın kitabı" dramı bu səpgidə yazılmış əsərlər sırasında öncül mövqedə dayanmaqla müəllifin fikir və düşüncələrinin bariz nümunəsi kimi diqqəti cəlb edir. Əsərdəki bütün surətlər sırası simvolik xarakter daşımaqla cəmiyyətin mövcud durumu və gələcək inkişaf perspektivlərini özündə ehtiva edir.

Akademik İsa Həbibbəyli yazır: "Ədibin əsərləri canlı xalq dilinin, Azərbaycan danışıq üslubunun təbii hadisəsidir. "Anamın kitabı" dramı azərbaycançılığın ədəbi manifestidir. Bu dahiyanə əsər Azərbaycanın tale kitabıdır." [1]

Əsərin baş qəhrəmanı Zəhra bəyim ana Vətəni, oğlanları Rüstəm, Mirzə Məhəmmədəli və Səməd Vahid birləşmək əvəzinə ayr-ayrı ölkələrə meyl edən, cəmiyyəti parçalayan ziyalıları, Gülbahar Azərbaycanın gələcəyini ifadə edirlər.

Çobanlar milli kökün təcəssümü kimi diqqəti cəlb edir. Ana son nəfəsində öz doğma oğlanlarını deyil, məhz onları dinləməklə təsəlli tapır.

Hər dəfə oğlanları mübahisə edəndə Ana qoynundan çıxardığı müqəddəs "kitab"la onları sakitləşdirməyə, barışığa çağırır. Lakin birlik çağırışlarına məhəl qoymayan, necə deyərlər, öz məsləkindən dönməyən qardaşlar yalnız ananın ölümündən sonra atalarının kitaba öz əliylə yazdığı vəsiyyəti dinləməklə sanki peşmanlıq hissi keçirirlər. Maraqlıdır ki, həmin vəsiyyəti də qardaşlarına Gülbahar oxuyur.

"Anamın kitabı"nda Gülbahar obrazı yeni Azərbaycanın simasıdır."[2] Əsərin ən maraqlı surətlərindən biri olan Gülbahar obrazı xüsusi məna daşıyır. Belə ki, əsərin əvvəlindən onun oynadığ rol getdikcə inkişaf etməklə əsərin sonunda aparıcı simaya çevrilir. O, C.Məmmədquluzadənin görmək istədiyi Azərbaycan cəmiyyətinin, Anadan sonra necə olması fikirlərini özündə təcəssüm etdirən simvolik rolu özündə tam əks etdirir. Müəllifin verdiyi işarəyə diqqət yetirək: *"Gülbahar--surətdə gözəl. Ümumi müsəlman qızları libasında, başında çarqat. Müsəlmanca savadlı. Anasını nəhayət istəyən. 20 yaşında."[3]*

Deməli, Cəlil Məmmədquluzadə Ana vətənin gələcəyini Gülbahar obrazında təqdim etməklə gələcək cəmiyyətimizin milli köklərə söykənməklə həm gözəl, həm də savadlı olmasını arzulayır. Qardaşlarından fərqli Gülbahar anasını-vətənini də çox sevir. Müəllif Gülbahar obrazını bu qiyafədə verməklə, bildirir ki, biri lüğət tərtib edən, digəri "üsuf-küsuf" duası yazan, üçüncüsü isə vaxtını mənasız şeir, qafiyə tutmaqla keçirən qardaşlardan cəmiyyətin gələcəyi üçün dərman ola bilməz.

"Anamın kitabı"ndakı Gülbahar obrazına yalnız Azərbaycan qadınlarının nümayəndəsi kimi baxmaq tamamilə yanlışdır. Gülbahar – qadınların və ya

kişilərin yox, Azərbaycan xalqının yeni nəslinin ümumiləşmiş obrazıdır.”[4]

Maraqlı səhnələrdən biri də qardaşların bacıları Gülbaharın evlənməsi ilə bağlı etdiyi mübahisədir. Rusiyada təhsil alan Rüstəm bəy Gülbaharı onun kimi “intileqent” olan dostuna, Nəcəfdə təhsil alan Mirzə Məhəmmədəli onu özü kimi “üsuf-küsuf” yazan Mirzə Baxşəliyə, kiçik qardaşı İstanbulda oxumuş Səməd Vahid isə türk dili müəllimi Hüseyn Şahidə vermək istəyir. Burada da şəxsi mövqedən çıxış edən qardaşlar Gülbaharın gələcək taleyini müəyyən edə bilmirlər. Qardaşlar burada da bir-birinə güzəştə getmək istəmirlər. Müəllif bununla Vətənin gələcəyini bu tip ziyalılara verməyin nə qədər ziyanlı və mənasız olduğu qənaətinə gəlir.

Obrazların açılması baxımından xeyriyyə cəmiyyətinin iclası xüsusi əhəmiyyət daşıyır. İclası pərdə arxasından izləyən Gülbahar gələcək həyat yoldaşını seçməlidir. Lakin qardaşlarının təklif etdiyi namizədlərdən heç biri Gülbaharın diqqətini cəlb etmir. Əksinə milli köklərindən uzaq bu insanlar onda yalnız gülüş və təəssüf hissi doğurur. Tədbirdən sonra qardaşlar Gülbahara yaxınlaşıb kimi bəyəndiyini soruşurlar...

“*G ü l b a h a r. Qardaşlarım, vallah, sözün doğrusu budur ki, çobanların danışdığından savayı mən bir söz başa düşmədim.” [3]*

Gülbahar yalnız öz doğma dillərində danışan çobanları anlayır. Hər üç qardaşın özü yadlaşdığı kimi onların göstərdikləri namizədlər də Gülbahara anlaşılmaz və yaddırlar. Böyük Cəlil Məmmədquluzadə bununla demək istəyir ki, Azərbaycanın gələcəyi bu tiplərlə mümkün deyil. Yalnız milli köklər üzərində durmaqla bu vətənin gələcəyini düşünmək olar.

Zəhra bəyim ana oğlanlarından evdən getməməyi, barışmağa çağırsa da, onlar nəinki geri qayıdır, hətta barışmağın mümkün olmadığını bildirirlər:

“R ü s t ə m b ə y. *Ana, bax, mən səni lap yaxşı başa salım: nə qədər ki, mən bu kitablara etiqad eləyirəm (öz kitabları tərəfə əlini tutur), Məhəmmədəli də bu kitablara (Mirzə Məhəmmədəlinin tərəfinə əlini uzadır) və Səməd də bu kitablara (Səməd Vahidə tərəf əlini uzadır) etiqad eləyirlər, dəxi biz nə təhər ittihad edib, mehriban yola gedə bilərik?” [3]*

Bu fikri Rüstəm bəy də, Mirzə Məhəmmədəli də etiraf edirlər. Ədib cəmiyyətin faciəsini bir ailənin simasında göstərməklə qurtuluşun milli birlikdə, barışığda olduğunu göstərir.

Z ə h r a b ə y i m (fikrə gedir). *Ürəyim, ürəyim (əlini qoyur ürəyinə) üç yerə bölünə, üç tikə ola, hər tikəsi də bir tərəfə çıxıb gedə (yenə baxır otağa), onda dəxi ürəyim parçalanar, ölərəm. Qızım, pəs mənim ürəyim üç parça olsa, sən nə elərsən?! Qızım, anasız qalarsan (dərin ah çəkir və huşa gedir).([3]*

Ananın bu sözləri birbaşa yad məsləklərə qulluq edən ziyalılarla açıq işarədir. ”*Qızım, pəs mənim ürəyim üç parça olsa, sən nə elərsən?! Qızım, anasız qalarsan.”* Dahi ədib bununla göstərmək istəyir ki, parçalanmış, tikə-tikə olmuş cəmiyyətin gələcəyi yoxdur, sahibsiz bu vətən yad əllərə möhtac ola bilər. Budur Mirzə Cəlilin böyüklüyü, dahiliyi!

Son saatını yaşayan ananın yanında oğlanları deyil, Gülbaharın çağırdığı çobanlar- Qurbandır, Qənbərdir, Zamandır. Qənbərin şirin danışığı, danışdığı əhvalatı, Zamanın tütəyinin səsi Zəhra bəyimə xoş gəlir. Onun dağılmış ruhuna məlhəm olur…

“G ü l b a h a r. *Necə, necə? Sən allah, Qənbər, necə? Bir nağıl elə görək.*

Q ə n b ə r. Xanımcan, and olsun allaha, bir dəfə mən özüm təəccüb qaldım… Xülasə, nə başınızı ağrıdım, xanımlar, Zaman başladı çalmağa… And olsun sizin əziz canınıza, qoyunlar tütəyin səsini eşidən kimi elə bil ki, bir şeydən ürkdülər. Eləcə getdikləri yerdə dayandılar, qulaqlarını qırpıtdılar. Elə bil, bir şeydən qorxan kimi geri döndülər və quyruqlarını ata-ata, mələşə-mələşə başladılar təpəyə tərəf geri qaçmağa…”[3]

Müəllifin Qənbərin diliyilə verdiyi mesajlar də simvolik məna daşıyır. Bir tərəfdən Ananın çağırışlarına məhəl qoymayan oxumuş, yüksək təhsil almış oğlanları, digər tərəfdən çobanın tütək səsinə geri qayıdan qoyunları qarşılaşdırmaqla Mirzə Cəlil millətin dərin faciəsini göstərir.

Oğlanlarından əli üzülmüş Ana sonda nəvazişlə qoruduğu kitabı Gülbahara təslim edir:

“Z ə h r a b ə y i m. *Qızım, bu kitabı al saxla yanında. Qardaşların yola getməyəndə kitabın bir yerində atanın yazısı var,--öz əlinən yazıb,--onu axtar tap, ver qardaşların oxusun. Onu oxusalar, daxı savaşmazlar. Onu atan öləndən iki gün qabaq öz əlinən yazdı (durur ayağa) əli titrəyə-titrəyə yazdı; elə naxoş ola-ola yazdı. Dedi uşaqlar oxusunlar. Qız, yapış əlimdən, qalxa bilmirəm.” [3]*

Müəllif burada da Ananın obrazında vətənin xəstə, çətin vəziyyətdə olduğunu, lakin nə qədər çətin olsa da, Gülbahar surəti ilə gələcəyin ümidsiz olmadığının işarəsini verir.

Əsərdə Gülbaharın kitablar üçün gələn hamballa dialoqu da maraq doğurur:

“G ü l b a h a r. *Ay hammal qardaş, bir mənə de görüm, axır adamlar niyə hərə bir yana gedir?*

İ k i n c i h a m m a l. Xanım, pəs hara getsinlər?

G ü l b a h a r. Necə hara getsinlər? Mən axır səndən söz soruşuram ki, niyə hamısı bir yerə getmir, niyə hərə bir tərəfə gedir? Bax, görürsən, o adamlar o tərəfə gedir, bu adamlar bu tərəfə gedir; mən bu işi başa düşmürəm. Yəqin ki, dəli olublar.” [3]

Müəllif burada da cəmiyyətin də üç qardaş kimi hərə bir tərəfə getdiyini, milli birliyin olmamasını sadə dildə bizə aşılayır. Hambal adamların hərə bir tərəfə getdiyini adi hal kimi qarşılayırsa, Gülbaharın emosional suallarıyla müəllif buna tamam ayrı məna verməklə vətənin gələcəyi üçün dərin narahatlığını bildirir.

Sonda qardaşlarının fikir ayrılıqlarının məğzində ayrı-ayrı məsləklərə aid kitabların durduğunu yəqin edən Gülbahar hər üç qardaşın kitablarını cırıb oda verir. C.Məmmədquluzadə deyir ki: “Yalnız bir kitab qalır, bu da Ananın bəyaz kitabıdır.”

Gülbahar evə qayıdan qardaşlarına anasının ona etibar etdiyi kitaba atasının ölümündən qabaq yazdığı vəsiyyəti oxuyur:

“*Yer, göy, aylar və ulduzlar göylərdə seyr edib gəzə-gəzə genə əvvəl-axır günün başına dolanırlar;*

çünki bunlar hamısı qədim əzəldə gündən qopub ayrılmış parçalardır. Mən etiqad edirəm ki, mənim də balalarım dünyada hər yanı gəzib dolansalar, genə əvvəl-axır anaları Zəhranın (əlini anasına tərəf tutur) ətrafında gərək dolanalar; çünki ay və ulduz şəmsin parçaları olan kimi, bunlar da analarının ayı və ulduzlarıdır...” [3]

Gülbaharın monoloqu da çox mənalardan xəbər verir. Xalq Cumhuriyyətinin süqutu dövründə yazılan pyesdə C.Məmmədquluzadə ay və ulduzların yenidən əvvəlki yerinə qayıdacağını söyləməklə gec-tez bu cumhuriyyətin yenidən qurulacağına inanır. Gülbahar adı da təsadüfi seçilməyib. Bununla ədib hər şeyin yenidən, ilk baharda olduğu kimi dirçələcəyinə inandığını ifadə edir. Kitabın Gülbahara verilməsi də simvolik məna daşıyır. Burada müəllif birlik, barışıq, gələcəyin simvolu olan kitabın Gülbahara təslimi ilə vətənin gələcəyinin birlikdən, qəti addımlardan keçdiyini bildirir. Əslində Gülbahar obrazı Anadan fərqli olaraq daha qətiyyətli, hətta deyərdim ki, üsyankardır. O, qardaşlarını bir-birindən ayıran kitablarını yandırıb oda verməklə öz kəskin etirazını bildirir. Müəllif bununla ölkə ziyalılarından vətənin gələcəyi naminə birləşməyə, onları birləşməyə qoymayan buxovlardan çətin olsa da, yaxa qurtarmağa çağırır.

Əsər bu gün üçün də öz aktuallığını saxlayır. Milli dövlət ideyası ətrafında birləşmək yerinə ayrı-ayrı xarici dövlətlərə meyllilik göstərən siyasi qruplara bir növ tarixi dərs örnəyidir “Anamın kitabı”.

Məqaləni C.Məmmədquluzadə yaradıcılığının böyük tədqiqatçısı, akademik İsa Həbibbəylidən bir sitatla bitirmək istəyirəm: “Əsərdəki çoban surətləri milli mənəviyyatın, xalq adət-ənənlərinin, doğma torpağa bağlılığın həqiqi yaradıcısı kimi çıxış edirlər. Cəlil Məmmədquluzadənin Gülbahar obrazı Azərbaycan ədəbiyyatında Vətən, millət və istiqlal amalının dramatik üvertürasıdır”.[2]

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TECHNICAL SCIENCES

METAL FORMING PROCESS SIMULATION BY FEA SOFTWARE

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PhD in mechanics of deformable bodies
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Abstract

This research explores the application of Finite Element Analysis (FEA) software in simulating metal forming processes, a crucial technique in modern manufacturing and engineering. FEA models the complex behavior of metals under various forming conditions, such as stamping, forging, and extrusion, by discretizing the workpiece and tooling into finite elements. This method allows for detailed analysis of stresses, strains, and deformations, helping optimize process parameters and tooling design, thereby improving product quality and reducing costs. Despite challenges like accurately modeling material properties and computational demands, FEA remains a powerful tool for enhancing understanding of material behavior, minimizing waste, and supporting sustainable manufacturing practices.

Keywords: Metal forming, Numerical simulation, Finite element analysis, Clinching.

Introduction

Metal forming process simulation using Finite Element Analysis (FEA) software is a critical approach in modern manufacturing and engineering. This technique allows engineers to model and analyze the complex behaviors of metals under various forming conditions, providing insights into the process's efficiency, quality, and cost-effectiveness. FEA software simulates the metal forming process by discretizing the metal workpiece and tooling into a finite number of elements. This discretization enables the detailed study of the material's response to external forces, such as stresses, strains, and deformations, during forming operations like stamping, forging, or extrusion. By applying the principles of continuum mechanics, the software can predict how the material will behave under different loading conditions, taking into account factors like material properties, temperature, and friction. The simulation helps in optimizing the forming process by identifying potential issues such as excessive thinning, cracking, or wrinkling of the metal sheet. It also allows for the design of appropriate tooling and the selection of suitable process parameters, thereby reducing trial-and-error experiments and minimizing production costs. Moreover, FEA simulations can enhance the understanding of the flow of material, stress distribution, and energy consumption during the forming process [1-6].

The Role of Numerical Simulation

Metal forming process simulation using Finite Element Analysis (FEA) software offers several significant advantages in manufacturing and engineering:

1. Reduced Development Time and Costs: By simulating the metal forming process virtually, FEA software reduces the need for physical prototyping and trial-and-error experimentation. This leads to quicker design iterations, saving both time and resources.

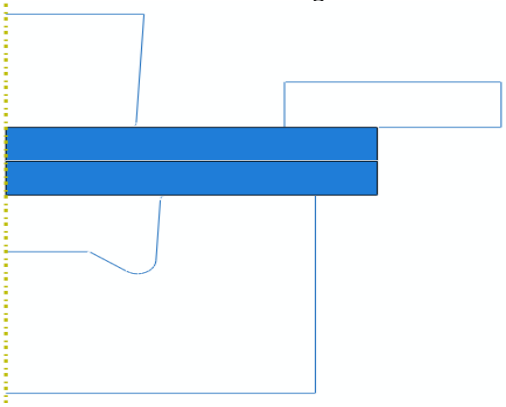

Figure 1. Modeling of the process [7]

2. Enhanced Product Quality: FEA simulations allow engineers to predict and analyze potential issues like thinning, cracking, or wrinkling in the metal workpiece. By identifying these problems early, engineers can optimize the process parameters and tooling design to achieve higher-quality products.

3. Improved Process Understanding: The detailed analysis provided by FEA software helps in understanding the material flow, stress distribution, and strain patterns during the forming process. This knowledge is crucial for optimizing the process and ensuring the final product meets the desired specifications.

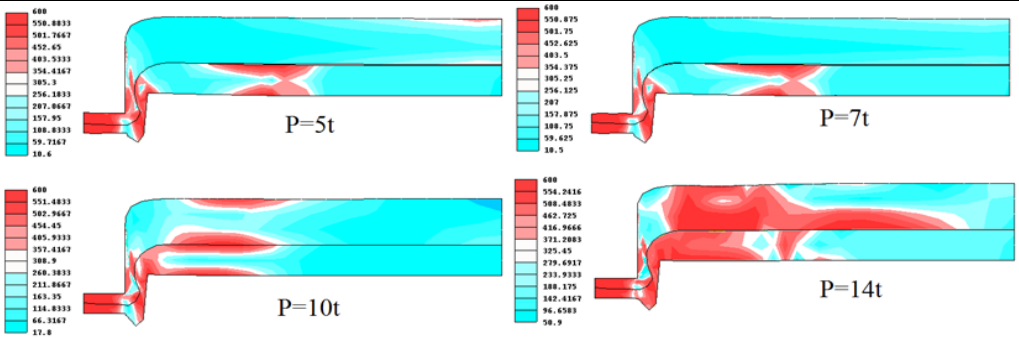

Figure 2. Stress distribution on the layers[8]

4. Optimization of Tooling and Materials: FEA simulations enable the precise design of tooling and the selection of appropriate materials for specific forming processes. This optimization ensures efficient use of resources and enhances the durability and performance of the tools.

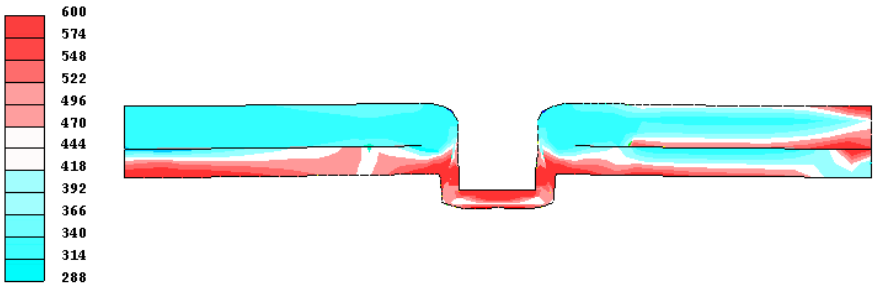

Figure 3. Permanent deformation illustration

5. Minimized Material Waste: By accurately predicting the behavior of materials under various conditions, FEA software helps in minimizing material waste. This is particularly important in industries where materials are expensive or where sustainability is a key concern [9, 10].

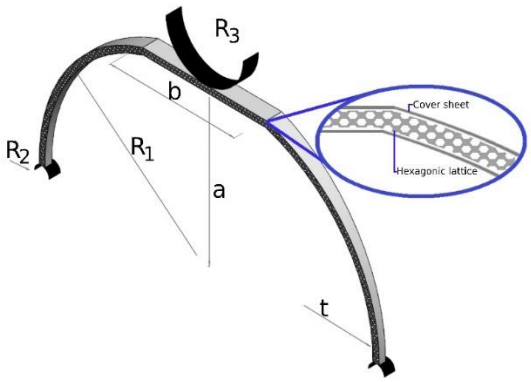

Figure 4. light weighting of parts by latticing [11]

6. Safety and Reliability: Simulating the forming process allows engineers to assess the safety and reliability of the process before actual production begins. This can prevent accidents and failures, ensuring a safer work environment and more reliable products [12-17].

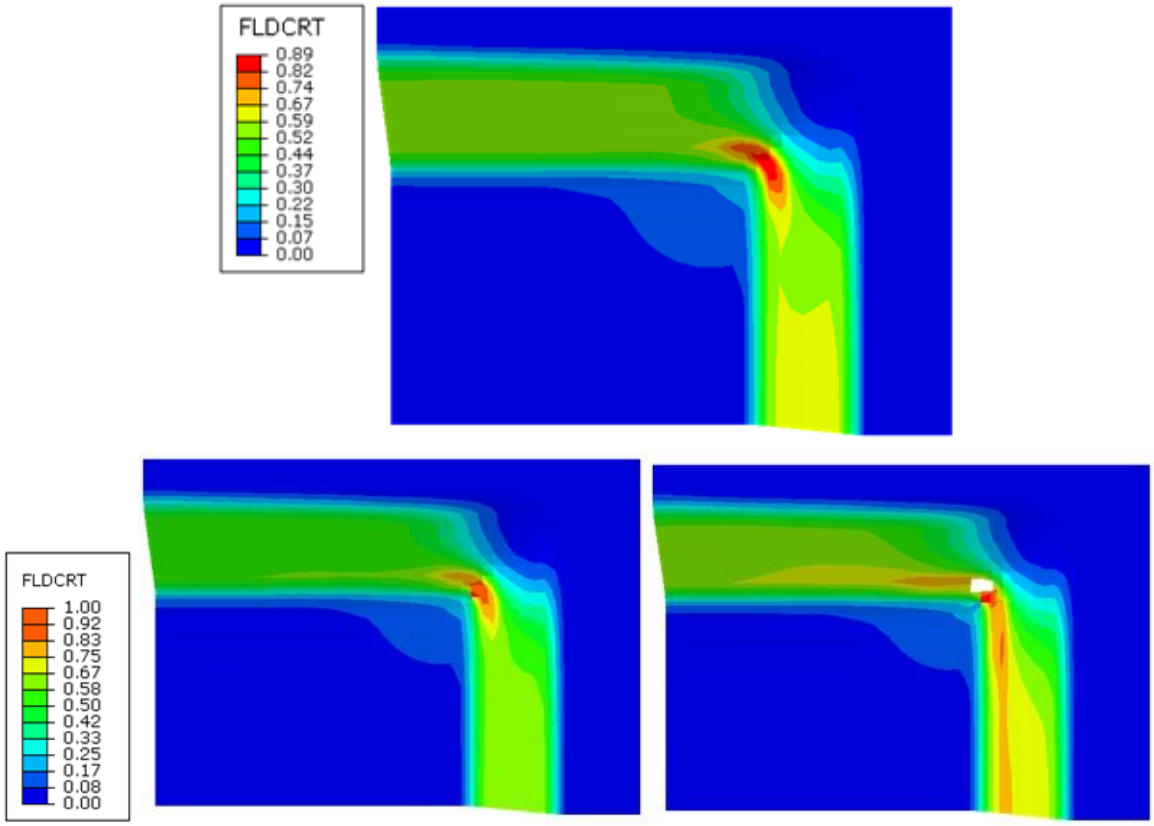

Figure 5. Damaged zones visualization

7. Flexibility in Process Design: FEA software provides flexibility in experimenting with different process parameters, materials, and geometries. Engineers can explore various design scenarios without the need for costly physical modifications, leading to innovative solutions and improvements.

8. Documentation and Data Analysis: FEA simulations generate comprehensive data and documentation, which can be used for further analysis, optimization, and quality control. This data-driven approach supports continuous improvement and knowledge retention within the organization.

9. Environmental Benefits: By reducing material waste, optimizing energy consumption, and improving process efficiency, FEA simulations contribute to more sustainable manufacturing practice.

Challenges and Future Directions

While metal forming process simulation using Finite Element Analysis (FEA) software offers numerous advantages, it also presents several challenges. One of the primary challenges is accurately modeling the material properties and behavior, particularly under complex loading conditions and high strain rates. Metals can exhibit nonlinear, anisotropic, and rate-dependent behaviors, making it difficult to capture their response precisely. The accuracy of the simulation is highly dependent on the quality of the material data and the constitutive models used [18-22].

Another challenge lies in the computational requirements. FEA simulations, especially those involving large-scale models with fine mesh resolution, can be computationally intensive and time-consuming. This necessitates significant computational resources and expertise in setting up and running simulations efficiently. Additionally, the choice of mesh size and element type can impact the accuracy and convergence of the results, requiring careful consideration and potentially iterative refinement.

Contact modeling between the workpiece and tools is another complex aspect of FEA simulations. Accurately representing friction, adhesion, and other contact phenomena is crucial for realistic simulations but can be challenging due to the need for precise definition of contact conditions and parameters. Inaccurate modeling of these interactions can lead to errors in predicting material flow and defect formation.

Furthermore, the validation of simulation results against experimental data poses a challenge. Experimental validation is necessary to ensure the reliability and accuracy of the simulation, but it can be difficult to obtain detailed and accurate experimental data, especially for complex processes. Discrepancies between simulated and experimental results may arise due to simplifications and assumptions made in the model, as well as uncertainties in material properties and boundary conditions.

Lastly, the continuous evolution of materials and manufacturing technologies requires ongoing updates and validation of FEA models and techniques. Engineers and researchers must stay current with advances in material science, simulation software, and computational methods to ensure the relevance and accuracy of their simulations. Despite these challenges, ongoing developments in FEA technology, material characterization, and computational power continue to improve the capability and accuracy of metal forming process simulations.

Predicting Material Behavior

Numerical simulations play a crucial role in predicting the behavior of materials under various loading and environmental conditions. In contact mechanics, this involves understanding how materials will respond to contact stresses, including elastic and plastic deformation, fracture, and fatigue. Advanced material models incorporated into simulations allow for accurate predictions of these behaviors, aiding in the selection of suitable materials for specific applications. For example, simulations can predict the lifespan of a component under cyclic loading, helping to prevent premature failure and enhance safety.

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THE IMPACT OF CLOUD TECHNOLOGIES ON ACCELERATING DIGITAL TRANSFORMATION IN ENTERPRISES

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Abstract

The article examines the impact of cloud technologies on accelerating digital transformation in enterprises. It analyzes the evolution of cloud computing and its role in transforming IT infrastructure, enhancing operational efficiency, and driving innovation. The study includes empirical examples from General Electric, Capital One, and Johnson & Johnson, demonstrating substantial improvements in business agility, cost savings, and productivity. The integration of advanced technologies such as artificial intelligence and machine learning within cloud platforms is also explored, highlighting the strategic benefits for enterprises. The findings underscore the pivotal role of cloud technologies in fostering a resilient and adaptable business environment.

Keywords: cloud technologies, digital transformation, IT infrastructure, operational efficiency, artificial intelligence, machine learning, business agility.

Introduction

Digital transformation involves integrating digital technologies into all areas of business, fundamentally changing how enterprises operate and deliver value to customers. Central to this transformation is cloud computing, which provides scalable, flexible, and cost-efficient IT resources, enabling businesses to innovate and respond quickly to market demands.

The adoption of cloud computing has revolutionized IT infrastructure management, transitioning from traditional, on-premises setups to flexible, scalable, and cost-effective cloud-based solutions. This transition allows enterprises to respond more swiftly to market changes and customer demands, fostering a more resilient and adaptable business model. Cloud technologies (CT) support advanced analytics, artificial intelligence (AI), and machine learning (ML) applications, further accelerating the pace of innovation and efficiency improvements. This article aims to explore the theoretical frameworks and practical impacts of CT on the digital transformation of enterprises. The article examines the evolution of CT and their role in transforming IT infrastructure, the theoretical foundations linking the adoption of CT to business efficiency, and empirical data supporting these theoretical claims.

Main part. Evolution of CT and their role in business transformation

The development of CT has been a pivotal factor in the digital transformation of businesses. Cloud computing has evolved from basic storage solutions to comprehensive platforms that support a wide range of services and applications [1]. This evolution can be divided into several key phases, each marked by significant technological advancements and changes in business practices.

In the early 2000s, cloud computing primarily offered **Infrastructure as a Service (IaaS)**, providing businesses with virtualized computing resources over the internet. This model allowed companies to rent computing power and storage, reducing the need for physical hardware and enabling more flexible and cost-effective IT management. Early adopters benefited from reduced capital expenditures and the ability to scale resources according to demand.

Around the mid-2000s, the second phase saw the introduction of **Platform as a Service (PaaS)**, which provided a more integrated environment for application development and deployment. PaaS solutions offered businesses the tools and services needed to develop, test, and deploy applications without managing the underlying infrastructure. This shift significantly accelerated development cycles and allowed for more rapid innovation.

By the late 2000s and early 2010s, **Software as a Service (SaaS)** emerged as the third major phase, transforming how businesses accessed and utilized software. SaaS delivered software applications over the internet on a subscription basis, eliminating the need for complex installations and maintenance. This model provided businesses with easy access to the latest software versions and features, enhancing productivity and collaboration across organizations.

The current phase, which began in the mid-2010s and continues into 2024, is characterized by the advent of **hybrid and multi-cloud environments**, as well as the integration of advanced technologies such as AI, ML, and big data analytics [2]. Hybrid cloud solutions combine private and public cloud resources, allowing businesses to optimize their IT strategies by balancing security, cost, and performance. Multi-cloud environments enable organizations to use multiple cloud services from different providers, enhancing flexibility and avoiding vendor lock-in. The global market for IaaS is projected to reach $180 billion in 2024, PaaS $176 billion, and SaaS $247 billion [3]. These substantial market sizes reflect the critical role these cloud services play in supporting the digital transformation of enterprises worldwide.

The evolution of CT over the past two decades has significantly impacted business transformation by providing scalable, flexible, and efficient IT solutions. As cloud computing continues to advance, its role in enabling innovation, improving operational efficiency, and fostering collaboration will remain critical for businesses seeking to thrive in the digital age.

The role of CT in business transformation

Facilitating the integration of advanced IT solutions, supporting innovation, and providing the infra-

structure necessary for deploying cutting-edge applications are key functions of CT. The strategic adoption of cloud computing enables businesses to respond swiftly to market changes, streamline operations, and improve overall business performance.

The benefits of CT in business transformation can be categorized into several key areas, including cost efficiency, operational flexibility, enhanced collaboration, data security, and the ability to leverage advanced technologies such as AI and ML. These benefits collectively contribute to the creation of a more dynamic and responsive business environment (table 1).

Table 1.

Key roles of CT in business transformation [4, 5]

Role	Description	Benefits	Examples
Cost efficiency	Reduces capital expenditures by minimizing the need for physical infrastructure and maintenance costs.	Lower operational costs, reduced need for on-site IT staff, and minimized hardware investments.	Transition to IaaS for scalable computing resources.
Operational flexibility	Enables businesses to scale IT resources according to demand, ensuring optimal performance.	Improved resource allocation, reduced downtime	Dynamic scaling of resources during peak business periods.
Enhanced collaboration	Facilitates seamless communication and collaboration across dispersed teams.	Increased productivity, real-time collaboration, and efficient project management.	Use of cloud-based collaboration tools like Microsoft Teams and Slack.
Data security	Provides robust security measures and compliance with regulatory standards.	Enhanced data protection, reduced risk of data breaches.	Implementation of cloud security services such as encryption
Disaster recovery	Business continuity through efficient backup and recovery solutions.	Minimized downtime, quick recovery from data loss	Utilization of cloud-based backup services like AWS Backup.
Advanced analytics	Supports big data processing and analytics, enabling data-driven decision making.	Better insights into business operations, informed strategic decisions	Use of cloud-based analytics platforms like Google BigQuery.
Access to AI and ML	Integrates AI and ML capabilities to automate processes and gain deeper business insights.	Enhanced automation, improved customer experiences, optimized business processes.	Deployment of AI/ML models using platforms like Azure ML.

The integration of CT reshapes business operations by enhancing organizational flexibility, enabling rapid scalability, and fostering a more responsive approach to market dynamics. From the author's perspective, these technologies facilitate innovation and efficiency, providing essential infrastructure for developing and deploying new applications. Cloud solutions also enhance collaboration across global teams and improve data security and compliance. By supporting advanced analytics and integrating AI and ML capabilities, CT empower businesses to make data-driven decisions and automate processes, thereby driving substantial digital transformation and opening new avenues for growth and development [6].

Examples of IT infrastructure transformation through CT

The transformation of IT infrastructure through the adoption of CT has been a pivotal strategy for many enterprises aiming to enhance their business efficiency. **General Electric (GE)**, a leader in industrial manufacturing and services, transformed its IT infrastructure using CT to enhance its industrial operations and maintain competitive advantages. A crucial element of GE's digital transformation is the development and deployment of Predix, an industrial cloud platform specifically designed for the industrial Internet of Things (IIoT). Predix integrates advanced data analytics, ML and IoT capabilities, enabling GE to collect and analyze vast amounts of data from its machinery and operations.

The adoption of Predix has led to significant improvements in operational efficiency, predictive maintenance, and overall performance of GE's industrial equipment. For instance, by using Predix, GE can monitor the health of jet engines in real-time, predict potential failures before they occur, and schedule maintenance proactively, thereby reducing downtime and operational costs. The migration of critical applications to the cloud has allowed GE to consolidate its data centers, leading to substantial cost savings and scalability benefits.

GE's cloud strategy also includes partnerships with major cloud providers like Amazon Web Services (AWS) and Microsoft Azure, which offer the necessary infrastructure and services to support Predix and other cloud initiatives. These collaborations have enabled GE to leverage cutting-edge CT, enhance its data processing capabilities, and ensure robust security and compliance with industry standards.

The benefits of the cloud transformation are evident in GE's improved operational efficiency and financial performance. GE achieved an operating profit of approximately $10,191 billion in 2023, a substantial turnaround from an operating loss of around $799 mil-

lion in 2022 [7]. This dramatic improvement underscores the effectiveness of GE's strategic investments in CT and its focus on enhancing operational efficiency through digital transformation.

Capital One, one of the largest and most innovative banks in the United States, has transformed its IT infrastructure by adopting a cloud-first strategy. Recognizing the potential of CT to enhance agility, security, and innovation, Capital One migrated a significant portion of its applications and data to AWS. This strategic move was driven by the need to modernize its IT infrastructure, improve customer experiences, and stay ahead in the competitive financial services industry.

The cloud migration has enabled Capital One to leverage advanced technologies such as ML, AI, and big data analytics. One notable example is the development of ML models for real-time fraud detection and prevention. By analyzing transaction patterns and customer behavior, these models can identify and flag suspicious activities instantly, thereby enhancing the security of customer accounts and reducing fraud losses.

In addition to enhancing security, the cloud infrastructure supports Capital One's DevOps practices, allowing for continuous integration and continuous delivery (CI/CD) pipelines. This capability has significantly accelerated the development and deployment of new features and services, ensuring that Capital One can rapidly respond to changing customer needs and market demands. Furthermore, the scalability offered by AWS has allowed Capital One to efficiently handle peak loads, such as those during major promotional campaigns or holiday seasons, without compromising performance.

Digital transformation has significantly influenced Capital One's Domestic Card Purchase Volume. The adoption of CT and the enhancement of digital services have contributed to the increase in transaction volumes (fig.1).

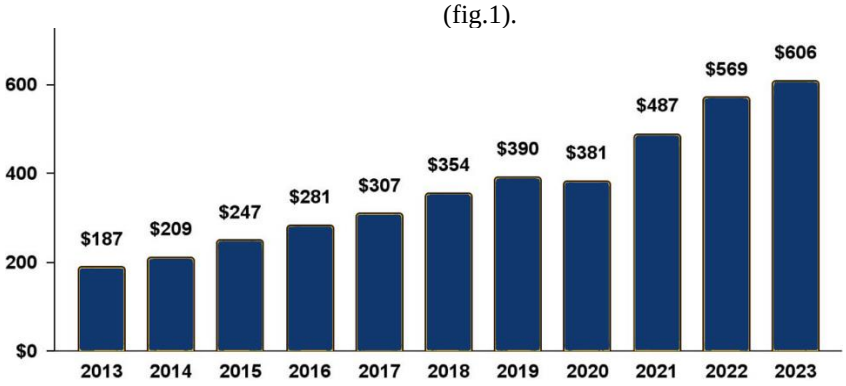

Figure 1. Capital One domestic card purchase volume [8]

Capital One has also embraced data mesh architecture to enhance data governance and scalability. By decentralizing data ownership and enabling domain-oriented data product management, the data mesh framework has empowered various teams to manage their data independently, fostering innovation and agility while maintaining high standards of data quality and compliance. Capital One has adopted AWS Lambda and serverless architecture to improve scalability and reduce operational overhead. This serverless approach enables the bank to run code in response to events without provisioning or managing servers, thereby enhancing operational efficiency and allowing developers to focus on building and deploying applications more rapidly.

Johnson & Johnson, a global leader in pharmaceuticals and consumer health products, has significantly transformed its IT infrastructure through the adoption of CT, focusing on predictive logistics to streamline its supply chain operations and enhance healthcare delivery. This strategic shift is part of the company's broader initiative to accelerate digital transformation and maintain its competitive edge in the healthcare industry.

Recognizing the potential of cloud computing to enhance operational efficiency and innovation, Johnson & Johnson migrated a substantial portion of its logistics applications and data to cloud platforms like AWS and Microsoft Azure. This migration has enabled the company to utilize advanced analytics, ML, and AI to predict logistics needs accurately and manage the supply chain more effectively.

By integrating predictive analytics into its logistics operations, Johnson & Johnson can forecast demand for its products with high precision. The cloud-based predictive models analyze vast amounts of data from various sources, including market trends and real-time inventory levels. This allows the company to optimize inventory levels, reduce the risk of stockouts or overstock situations, and create a more responsive and resilient supply chain.

The cloud infrastructure has also improved collaboration across Johnson & Johnson's global logistics network. With cloud-based platforms, different stakeholders, including suppliers, manufacturers, and distributors, have secure and real-time access to critical logistics data. This enhanced visibility facilitates better coordination and decision-making, ensuring that products are delivered efficiently and on time. The scalability of cloud platforms allows Johnson & Johnson to handle peak logistics demands without compromising performance.

In 2022, the company's revenue was approximately $94 billion, and it saw an increase to about $99 billion in 2023. This growth underscores the positive impact of leveraging CT and predictive logistics in enhancing operational efficiency and meeting market demands more effectively.

In addition to its logistics transformation, Johnson & Johnson has revolutionized its healthcare delivery and medical training through CT. The Johnson & Johnson Institute has implemented a high-tech approach to continuous medical education, utilizing cloud-based platforms to provide advanced training programs for surgeons and healthcare professionals. These programs leverage virtual reality and augmented reality to offer hands-on training in a simulated environment, accessible worldwide, and ensure real-time updates with the latest medical advancements.

To support these initiatives, Johnson & Johnson employs approximately 6,000 data scientists and digital experts embedded across its businesses globally. These professionals drive the company's digital transformation by developing innovative solutions, optimizing operations, and enhancing data-driven decision-making.

In 2023, Johnson & Johnson remained a top investor in innovation, funding $15.1 billion in R&D, or almost 18% of 2023 sales – an all-time high for the company [9]. This significant investment underscores Johnson & Johnson's commitment to advancing healthcare through continuous innovation and digital transformation.

Conclusions

The integration of CT has profoundly accelerated digital transformation within enterprises by offering scalable, flexible, and cost-effective IT solutions. Cloud computing facilitates advanced analytics, AI, and ML applications, which drive innovation and operational efficiency. The empirical evidence from various enterprises illustrates the substantial improvements in business agility, cost savings, and productivity following cloud adoption. Companies like General Electric, Capital One, and Johnson & Johnson have demonstrated significant operational enhancements and financial gains, underscoring the transformative power of CT in reshaping IT infrastructure and fostering a more resilient and responsive business model. As CT continue to evolve, their role in enabling comprehensive digital transformation remains pivotal, supporting businesses in navigating the dynamic market landscape and sustaining competitive advantages.

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