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STEMedu

INNOVATIVE STEM EDUCATION
ИНОВАТИВНО STEM ОБРАЗОВАНИЕ

STEMedu-2024

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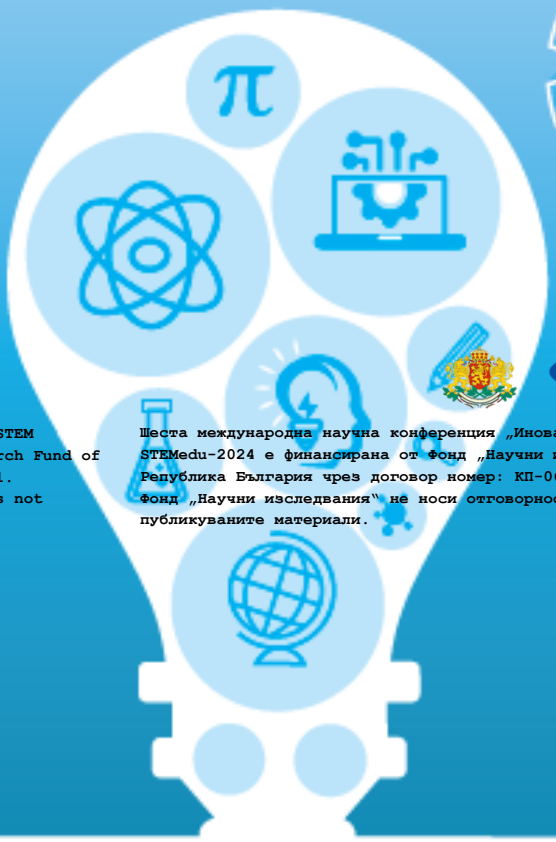
2024, Veliko Tarnovo, Bulgaria



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PREFACE

The Sixth International Scientific Conference "Innovative STEM Education" (STEMedu-2024) is an interdisciplinary forum that started in 2018. Its main goal is to popularize the educational concept of STEM/STEAM in Bulgarian conditions, which offers a complex approach to teaching and learning and combines science, technology, engineering, arts and mathematics. The forum emphasizes innovative technologies in the fields of education, robotics, medical and engineering sciences, as well as technology-mediated learning in mathematics, life sciences, and more. According to a tradition established over the years, the event also pays special attention to the topics of digital accessibility, various educational technologies and platforms for sharing knowledge, etc.

In 2024, the event will take place from October 6 to 10, 2024 in Veliko Tarnovo, Bulgaria. The topics presented by the speakers are organized and included in the sessions:

- Modern methods and technologies in engineering sciences;
- Innovative educational technologies: mathematics and informatics;
- Innovative technologies in education. e-Learning;
- STEM/STEAM education. Innovations in learning;
- STEM/STEAM environments and learning;
- Accessibility for people with special needs;
- Innovative technologies and their application in healthcare.

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ПРЕДГОВОР

Шеста международна научна конференция „Иновативно STEM образование“ (STEMedu-2024) е интердисциплинарен форум, който стартира през 2018 г. Неговата основна цел е насочена към популяризиране на образователната концепция за STEM/STEAM в българските условия, която предлага комплексен подход към преподаването и ученето и съчетава наука, технологии, инженерство, изкуства и математика. Форумът поставя акцент върху иновативни технологии в областите образование, роботика, медицински и инженерни науки, както и технологично опосредствано обучение по математика, науки за живота и др. По утвърдена в годините традиция в събитието се отделя специално внимание и върху тематиките за дигиталната достъпност, различни образователни технологии и платформи за споделяне на знания и др.

През 2024 г. събитието се провежда от 06 до 10 октомври 2024 г. в гр. Велико Търново, България. Представяните от докладчиците теми са организирани и включени в сесиите:

- Съвременни методи и технологии в инженерните науки;
- Иновативни образователни технологии: математика и информатика;
- Иновативни технологии в образованието. e-Learning;
- STEM/STEAM образование. Иновации в обучението;
- STEM/STEAM среди и обучение;
- Достъпност за хора със специални потребности;
- Иновативни технологии и тяхното приложение в здравеопазването.

Специални благодарности на Фонд „Научни изследвания“ на Република България за частичното финансиране на международна научна конференция „Иновативно STEM образование“ (STEMedu-2024) чрез договор с номер: КП-06-МНФ/31.
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ADDING ART INTO THE EQUATION: A STEAM APPROACH TO EMBEDDED SOFTWARE COURSE

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ДОБАВЯНЕ НА ИЗКУСТВО КЪМ УРАВНЕНИЕТО: STEAM ПОДХОД КЪМ КУРСА ЗА ВГРАДЕН СОФТУЕР

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Abstract: *This report presents the experience of extending an Embedded Systems Programming class to include GUI design elements. Employing graphical user interfaces in embedded devices has been an increasing trend of the last decade, and introducing it also into courses concerning embedded systems and microcontrollers is in demand. GUI programming not only involves knowledge about the programming frameworks and toolkits used in embedded environments, but also artistic concepts about graphics design, mostly in the form of drawing concepts and digital arts. Teaching engineering students about graphic design has benefits in two ways: increases the appeal of the course and also leads to better understanding the interaction between the two worlds: arts and engineering. Survey results after finishing the course show a high appeal and a high satisfaction level among the students.*

Keywords: *STEAM Education; Embedded Systems Programming; GUI Design.*

MATHEMATICAL BASIS OF USABILITY

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МАТЕМАТИЧЕСКИ ОСНОВИ НА ИЗПОЛЗВАЕМОСТТА

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Abstract: Mathematical notation is a system of symbolic representations of mathematical objects and ideas. It includes simple symbolic representations such as numbers, functions, symbols, variables and also more complex symbols like matrices. User input of mathematical notation by means of standard input devices – a computer keyboard and a mouse – presents several challenges. These arise mostly from the fact that these devices were designed for a different purpose - for input of plain text with the addition of a limited support for keyboard commands and the ability to mark a single spot on the screen.

Keywords: *Symbols; Mathematics; Notation; Keyboard; Mouse.*

STEM EDUCATION FOR UNDERGRADUATES IN ENGINEERING

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STEM ОБРАЗОВАНИЕ ЗА СТУДЕНТИ ПО ИНЖЕНЕРСТВО

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Abstract: *Published works convince us that time has come for engineering faculty to rethink approaches for STEM teaching and learning of engineering undergraduates. We must work collaboratively on STEM education emphasizing engineering in terms of broad, reflective, and corrective framework accommodating reality of engineering practice, society and environment. Approaches cannot avoid increased application of artificial intelligence. The presentation will start with a brief discussion on how STEM education has evolved and realization that time has come to be pragmatic in designing STEM education in engineering in classroom setting for undergraduate engineering students. We will review published research works on engineering STEM education to highlight some challenges with the hope of initiating a discussion that will lead us to find ways to make necessary paradigm change in the engineering STEM education. Presentation will include possible approaches to design future STEM education for undergraduate engineering students considering various limitations and regulations with the understanding that flexibility in the engineering teaching is important.*

Keywords: STEM Education; Undergraduates Engineering Students; STEM teaching.

STEM Lesson – Science of the Rose

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STEM урок – Наука за розата

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Abstract: *For the development of the STEM trend in education and the use of interdisciplinary approaches and research methods in teaching, suitable topics for creating lesson units can be used as a basic starting point. The aim of this paper is to present an interdisciplinary lesson combined with research methods, which is on the topic of 'Science of the Rose'. An interdisciplinary connection has been made on the subject in the following academic disciplines: biology, chemistry, physics, history and geography. Tasks are presented for students to perform, applying the project-based approach and the research approach. The applied tasks for the derivation of scientific research results outline the basis of the formation of natural science competences and the development of natural science literacy in students. It is the most appropriate strategy to promote active learning, which covers different hierarchical levels of Bloom's taxonomy, creating a supportive, intellectual and emotional environment for the development of research activity at school.*

Keywords: *STEM Education; Interdisciplinarity; Project-based Approach; Research Approach and Science Literacy.*

EVALUATION OF CONTEMPORARY EASSESSMENT PLATFORMS: FUNCTIONAL REQUIREMENTS AND TECHNOLOGICAL APPROACHES

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ОЦЕНКА НА СЪВРЕМЕННИ ПЛАТФОРМИ ЗА ЕЛЕКТРОННО ОЦЕНЯВАНЕ: ФУНКЦИОНАЛНИ ИЗИСКВАНИЯ И ТЕХНОЛОГИЧНИ ПОДХОДИ

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Abstract: *Assessment is an extremely important process in an education, which is used as a measure of the acquired knowledge and skills of the learners. In the modern world, a number of technological tools and platforms have been developed to support activities related to eAssessment by the learner and the teacher. The purpose of the paper is to present research conducted on contemporary technological solutions for eAssessment, their functions, advantages and disadvantages. For this purpose, a study of the scientific production in the field is performed, and the achievements are summarized and discussed. A criteria scale is developed for evaluation and selection of a technological solution of an eAssessment platform for further experimentation. Particular attention is paid to security and protection of personal data, collected and transferred during an assessment process.*

Keywords: *Platforms for eAssessment; Technological Solution; Functional Requirements; Evaluation Criteria; Security and Privacy.*

Резюме: *Оценяването е изключително важен процес в едно образование, което се използва като мярка за придобитите знания и умения на обучаемите. В съвременния свят са разработени редица технологични инструменти и платформи за подпомагане на дейности, свързани с електронното оценяване от обучаемия и учителя. Целта на статията е да представи проведени изследвания върху съвременни технологични решения за електронно оценяване (еОценяване), техните функции, предимства и недостатъци. За целта е извършено проучване на научната продукция в областта, като се обобщават и обсъждат постиженията. Разработена е критериална скала за оценка и избор на технологично решение на*

платформа за еОценяване за по-нататъшно експериментиране. Особено внимание се обръща на сигурността и защитата на личните данни, събрани и прдавани по време на процеса на оценяване.

Ключови думи: *платформи за електронно оценяване; технологично решение; функционални изисквания; критерии за оценка; сигурност и поверителност.*

STEM Approach to Build Competences from Automata and Languages Theory

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STEM подход за изграждане на компетентности от теория на автоматите и езиците

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Abstract: *The paper presents a STEM approach to teaching undergraduate computer science students. This approach relies on interdisciplinary connections between mathematics and informatics and uses programming as a didactic tool. STEM educational methods applicable to computer science majors are explored and analyzed. A system of learning tasks for algorithms dealing with finite automata, stack automata, and nondeterministic automata is presented. Attention is paid to the formation of lasting knowledge and skills, increasing the motivation of the students and the application of theoretical statements in practice.*

Keywords: *Cross-curricular Connections; STEM; Computer Science; Automata; Formal Languages; Programming.*

INNOVATIVE TECHNOLOGIES AND APPROACHES FOR EDUCATION IN THE FIELD OF CULTURE AND ARTS

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ИНОВАТИВНИ ТЕХНОЛОГИИ И ПОДХОДИ ЗА ОБУЧЕНИЕ В СФЕРАТА НА КУЛТУРАТА И ИЗКУСТВАТА

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Abstract: *In focus will be presented modern innovative technologies, approaches and examples of education and learning, especially in the fields of culture, languages and art.*

They are important for future development of education for new generations and for keeping the audiences engaged, focused and motivated. Experiencing and discovering while learning also leads to better results in terms of remembering and interpreting information, developing skills, putting it into practice, being inventive, connecting pieces of knowledge and life, etc. It includes living experiences, games, virtual and augmented reality, social media networking campaigns and challenges, smart education games, applications, including AI, etc.

It is also important to note that some of those new learning approaches are better and very suitable for specific audiences, including kids, youngsters, people with different disabilities, etc. For example, learning a language or a culture, while playing, interacting, and experiencing can overcome different social, distance, economic or cognitive barriers, fears, and challenges.

Резюме: *На фокус ще бъдат представени съвременни иновативни технологии, подходи и примери за образование и обучение, особено в областта на културата, езиците и изкуствата.*

Те са важни за бъдещото развитие при обучение на следващи поколения и за поддържане на аудиторията ангажирана, фокусирана и мотивирана. Преживяването и откриването по време на учене, също водят до по-добри резултати по отношение на запомнянето и тълкуването на информация, прилагането й на практика, развиването на умения, изобретателност, свързване

на знания с житейска действителност и т.н. Това включва живи преживявания, игри, виртуална и разширена реалност, нетуъркинг кампании и предизвикателства в социални мрежи, интелигентни образователни игри, приложения, използване на изкуствен интелект и др.

Също така е важно да се отбележи, че някои от тези нови подходи за учене са по-добри и много подходящи за специфични аудитории, включително деца, младежи, хора с различни увреждания и т.н. Например, изучаването на език или култура с игра, взаимодействате или преживявате, може да преодолее различни бариери - социални, икономически, физическа дистанция или когнитивни бариери, страхове и предизвикателства.

MAZE VIDEO GAMES FOR STEM TEACHING

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ВИДЕО ИГРИ-ЛАБИРИНТИ ЗА STEM ОБУЧЕНИЕ

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Abstract: *In last twenty years, STEM teaching methods are in the focus of regulation bodies, visionaries, decision-makers and practitioners in K12 and university education worldwide. Among the traditional approaches for STEM teaching based on problem solving, projects, collaboration and inquiries, nowadays gamification and game-based learning started gaining popularity as innovative, interactive and very engaging teaching methods. While gamification applies game elements and interactive simulations to teach STEM concepts, game-based learning relies on incorporation of educational content into digital games that learners play as a part of the learning process, for acquiring specific knowledge or skills. The paper presents 3D maze video games as effective tool for informal education proven in many previous case studies with K12 and university students. The video mazes are generated automatically by a software platform and are enhanced with various mini-games representing didactic tasks of different types. Despite the fact that most previous games have been in the field of cultural heritage, mazes have the potential to be used in STEM education as well. There are discussed the qualities of the mini-games included in maze halls, together with their possible application for STEM teaching. The paper concludes with some remarks about the positive appreciation of maze video games reported by both students and teachers that paves the way for their future application for a motivating and engaging game-based learning.*

Keywords: *Maze Video Games; STEM; Game-based Learning; Mini-games.*

SNOWFLAKE IN THE CONTEXT OF STEAM EDUCATION OR OVERCOMING A MISCONCEPTION

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СНЕЖИНКАТА В КОНТЕКСТА НА STEAM ОБРАЗОВАНИЕТО ИЛИ ЗА ПРЕОДОЛЯВАНЕТО НА ЕДНА МИСКОНЦЕПЦИЯ

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Abstract: *Key ideas about STEAM education are fleshed out on snowflake research. The focus is on the geometric shapes of snowflakes and several technologies for creating snowflake patterns. Computer environments, cutting plotter, augmented reality, 3D printer, drone, etc. were used for this purpose. Computer models that can be used to generate images of snowflakes are presented. Both basic steps to create some of the files and ways to use them to get pictures and animations are described. Typical mistakes in creating design patterns of snowflakes are presented. To overcome misconceptions, an opportunity to explore pictures of snowflakes with virtual dynamic constructions is proposed.*

Keywords: *STEAM; Computer Models; Augmented Reality; Digital Competence; Misconceptions; IBL; Critical Thinking.*

CONSTRUCTION OF TYPES OF QUADRILATERALS WITH A SIX-LEGGED EDUCATIONAL ROBOT

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ПОСТРОЯВАНЕ НА ВИДОВЕ ЧЕТИРИЪГЪЛНИЦИ С ШЕСТОКРАК ОБРАЗОВАТЕЛЕН РОБОТ

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Abstract: *Opportunities to create geometric figures by programming and using a mobile application with a six-legged educational robot are presented. Some ideas are described for creating scenarios to support information technology education, computer modeling, technology and entrepreneurship, and mathematics, as well as extracurricular robotics activities.*

Keywords: *STEAM; Robotic Systems; Mathematics; Information Technologies; Education; Digital Competence.*

HUMANOID ROBOT FOR TEACHING VISUALLY IMPAIRED LEARNERS

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ХУМАНОИДЕН РОБОТ ЗА ОБУЧЕНИЕ НА УЧАЩИ С УВРЕДЕНО ЗРЕНИЕ

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Abstract: *A pilot study of a training scenario to determine the reaction of mature people with visual impairment when interacting with a humanoid robot NAO was conducted. The main goal of the scenario is for visually impaired people to learn about the robot itself from the robot, when it was created, what it is, what it is made of, what it is equipped with, to get to know and feel by touch the parts of its body and some of its control options. The main observations are discussed in the paper, relevant to transferring the scenario to inclusive education.*

Keywords: *Visually Impaired People; Training Scenario; Humanoid Robot NAO.*

NEON Instruction Set Efficiency and their Use in

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Ефективност на NEON инструкции и тяхното използване в задачи от теория на кодирането

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Abstract: *A large number of algorithms solving Coding Theory problems involve operations on vectors over finite fields. The use of extended CPU registers and instructions is suitable for the optimization of these algorithms. Current work presents the Neon instruction set for the ARM architectures used in Apple's M series of processors. A method for their application in algorithms for finding weight characteristics is considered. Some basic similarities and dif erences with extended vector instructions available in other architectures are presented. Their performance is compared with non-vectorized methods.*

Keywords: *Vectorization, NEON Instruction Set.*

About Algorithms for Calculation of Covering Radius of Linear Codes

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Относно алгоритми за пресмятане на радиус на покритие на линейни кодове

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Abstract: *The covering radius is an important parameter of linear codes. Its calculation is an NP-complete problem. There are three main approaches to its computing that can be considered. The first method is based on traversing the cosets of the linear code. The second method uses the parity-check matrix of the code to calculate the covering radius. The third method is based on fast Walsh-Hadamard transforms for the binary case and Vilenkin-Chrestenson transform for the non-binary case. In this work, the first two approaches are consideredand some of the features of their implementations are presented.*

DATA MINING IN CYBERSECURITY

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АНАЛИЗ НА ДАННИ В КИБЕРСИГУРНОСТТА

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Abstract: *The article presents, summarizes and develops technological concepts of cyber security based on machine learning, data processing and analysis. The steps of cyber attacks, use of key techniques of data analysis in cyber defense, application of data processing and analysis in information security and tools used are presented.*

Keywords: *Cyber Security; Machine Learning; Data Processing and Analysis.*

Резюме: *Статията представя, обобщава и развива технологични концепции на киберсигурността основани на машинно обучение, обработката и анализа на данни,. Представени са стъпките на кибератаките, използване на ключови техники за анализа на данни в киберотбраната, приложение на обработката и анализа на данни в информационната сигурност и използвани инструменти.*

Ключови думи: *киберсигурност; машинно обучение; обработката и анализа на данни.*

GENERATING MENTAL STRESS THROUGH 3D GAME

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ГЕНЕРИРАНЕ НА МЕНТАЛЕН СТРЕС ЧРЕЗ 3D ИГРА

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Abstract: *The present article investigated the influence of mental stress on heart rate variability (HRV). The mental stress is generated through a newly created 3D game with high extremeness. The modelling of the main components of the game is done in two ways: automatically (algorithmically) using the Java programming language and manually (digitally) using Blender, the two methods can be combined by modeling with geometric objects, such as a regular polygon, a prism, pyramid and others. The controlled stress scenario can be created by appropriately planning graphic objects and elements, such as material and texture, including movement dynamics. Rapid and unexpected movements of game objects, as well as visual and sound effects, play a key role in generating mental stress and can significantly affect HRV. The HRV measurement methodology includes the following three phases: a preliminary phase, when baseline HRV levels are measured before the start of the game; the game phase-measurement of HRV during the game; and the post-game phase-measurements after the game. HRV analysis includes determining the values of the following parameters in the time and frequency domains: SDNN, RMSSD, LF, HF and LF/HF ratio. The results of the HRV analysis show that stress significantly impacts HRV and leads to its decrease, which is expressed in a significant decrease in SDNN and RMSSD, as well as an increase in the LF/HF ratio during a stressful situation. Investigating these changes is important for understanding the physiological functions of mental stress and may help develop mechanisms to manage it to improve human health.*

Keywords: *Virtual Reality; HMD; Mental Stress; Heart Rate Variability; 3D Game; Mathematical Analysis.*

VISUAL SIMULATION OF A DIGITAL HARDWARE MODEL

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ВИЗУАЛНА СИМУЛАЦИЯ НА МОДЕЛ НА ЦИФРОВ ХАРДУЕР

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Abstract: *Visual simulation in circuit design involves creating a software application that provides a dynamic visual representation of a digital system modeled with Hardware Description Languages (HDLs). This allows users to gain a deeper understanding of the system's behavior by observing the simulation in real-time. Additionally, the simulation data facilitates easier identification and correction of malfunctions in digital circuits models.*

This report explores the capabilities of the Visual Debug (VIZ) feature in the Makerchip IDE for creating a visual simulation of a stack-based calculator model. This model is specifically designed for online learning in digital hardware design courses offered by the Computer Systems and Technologies department at the Technical University of Gabrovo.

Keywords: *Visual Simulation; Digital Hardware Model; Stack-based Calculator; Makerchip IDE; Visual Debug.*

CONCERNING THE BEHAVIOR OF PASSENGERS WHEN CHOOSING A SEAT IN A COMPARTMENT PASSENGER RAILWAY CAR

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ОТНОСНО ПОВЕДЕНИЕТО НА ПЪТНИЦИТЕ ПРИ ИЗБОР НА МЯСТО В КУПЕЕН ПЪТНИЧЕСКИ ВАГОН

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Abstract: *This report presents the results of an empirical study of the behaviour of passengers when choosing a seat in a second class compartment passenger railway car. The most and least used seats are identified.*

Keywords: *Keywords: seating behavior, occupancy, compartment passenger railway car.*

OPPORTUNITIES FOR THE USE OF RESCUE DOGS IN THE FIRE SAFETY AND CIVIL PROTECTION DIRECTORATE GENERAL – MINISTRY OF THE INTERIOR

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ВЪЗМОЖНОСТИ ЗА ИЗПОЛЗВАНЕ НА СПАСИТЕЛНИ КУЧЕТА В ГДПБЗН-МВР

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Abstract: *The report examines the role of rescue dogs in search and rescue operations. The current situation and the regulatory framework in the Republic of Bulgaria have been analysed. All possibilities for the use of rescue dogs from the Fire Safety and Civil Protection Directorate General - Ministry of the Interior are indicated.*

Keywords: *Rescue Dogs; Fire Safety and Civil Protection Directorate General; SAR Operations.*

EXPERIMENTAL DETERMINATION OF THE PASSENGER CAR DECELERATION UNDER DIFFERENT ROAD CONDITIONS

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ЕКСПЕРИМЕНТАЛНО ОПРЕДЕЛЯНЕ НА СПИРАЧНОТО ЗАКЪСНЕНИЕ НА ЛЕК АВТОМОБИЛ ПРИ РАЗЛИЧНИ ПЪТНИ УСЛОВИЯ

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Abstract: *In this paper, the authors present an experimental study to determine the influence of the active safety system "ABS" on the braking deceleration of vehicles under different road surfaces and at different driving speeds. Different vehicles were used for the purpose of the experiment. The experiments were conducted in two stages. In the first stage of the experiment, the braking deceleration was measured with the 'ABS' system running, at different speeds and road surfaces. In the second stage of the experiment, under the same conditions, the braking deceleration was measured with the 'ABS' system deactivated. The purpose of this study is to analyse the influence of the 'ABS' system on the braking deceleration under different factors in a real environment. A modern method for determining the braking deceleration by applying the ENERGOTEST EnergoSM 4.0 non-contact speed and acceleration measurement system.*

Keywords: *ABS; Braking Deceleration; Braking Distance; Vehicle Braking.*

Резюме: *В този доклад авторите представят резултатите от експериментално изследване, което цели да определи влиянието на системата за активна безопасност (ABS) върху спирачното закъснение на превозни средства при различни пътни настилки и скорост на движение. За целта са използвани различни автомобили, а експериментите са проведени в два етапа. В първия етап спирачното закъснение се измерва с работеща система ABS при различни скорости и пътни настилки. Във втория етап, при същите условия, спирачното закъснение се измерва с деактивирана система ABS. Целта на изследването е да се анализира влиянието на ABS системата в реални условия. За измерването на спирачното закъснение е използван съвременен метод, който включва безконтактната система за измерване на скорост и ускорение ENERGOTEST EnergoSM 4.0.*

Ключови думи: *автомобилна безопасност; ABS; спирачно закъснение; спирачен път; спиране на автомобила.*

GEOMETRY, ALGEBRA, AND PROGRAMMING — A MOST GRATIFYING BLEND

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ГЕОМЕТРИЯ, АЛГЕБРА И ПРОГРАМИРАНЕ – ЕДНО МНОГО ПЛОДОНОСНО СЪЧЕТАНИЕ

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Abstract: *Computer-aided exploration in geometry is most often understood as interacting with a graphical image of a geometric scene. We have found another approach to be at last equally attractive, and often much more effective. In the ForGe system, a highly developed version of vector algebra is employed to perform calculations through which geometric objects are being constructed and their properties studied. ForGe is a language and its computer implementation for carrying out such calculations and drawing geometric scenes. Scripts in ForGe can be written by hand or generated programmatically, thus enabling creative blending of geometry, algebra, and programming.*

Keywords: *Euclidean Geometry; Vector Algebra; Programming; Exploration.*

Резюме: *Под геометрични изследвания с помощта на компютър най-често разбираме диалоговото взаимодействие с екранен образ на геометрична конфигурация. Според нас един друг подход е също толкова привлекателен, а често и по-ефикасен. В системата ForGe за построяване на геометрични обекти и изследване на свойствата им се използват пресмятания, опиращи се на високоусъвършенствана разновидност на алгебрата на векторите. ForGe е език и неговата компютърна реализация, предназначени за извършване на такива пресмятания и изготвяне на геометрични чертежи. Текстът-сценарий за ForGe може да бъде написан на ръка или породен от програма – в резултат геометрия, алгебра и програмиране могат да се съчетават по разнообразни начини.*

Ключови думи: *евклидова геометрия; алгебра на векторите; програмиране; изследване*

INFORMATION PRESENTER IN THE CONTEXT OF EDUCATION

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ИНФОРМАЦИОНЕН ПРЕЗЕНТАТОР В КОНТЕКСТА НА ОБРАЗОВАНИЕТО

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Abstract: *The Information Presenter is a combined online-desktop software system, which displays information to the users. In education, it can serve as a mnemonic matrix system, that can help students to learn, maintain their knowledge, find gaps in it and resolve them, as well as understand the material. The desktop component enables the student to always unobtrusively see a thumbnail of the currently loaded information item, which they can open for a full view with a click. This allows continuous learning even as students use their computers for other unrelated tasks. The online component enables educators to provide information to the students easily and in unlimited volume. Attaching tags to information items allows students to learn by any characteristic of the information as defined by the educator. The Information Presenter enables students and educators to implement several scientifically proven methods for improved learning, such as the Spacing effect, the Interleave concepts, and others. It also allows students to take part in teaching by creating information items. The software does not compete with the website of the educator or with the online sources of information, but complements them.*

Keywords: *Information Presenter; Spacing Effect; Interleave Concepts; Frequent Practice Tests; Continuous Learning; Flashcards.*

STEMx - Extreme Multidisciplinarity for Programming, Mathematics, Physics, and Biology Interwoven into One Agricultural Educational Project

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STEMx - Екстремна мултидисциплинарност за програмиране, математика, физика и биология, вплетени в един земеделски образователен проект

Невен Боянов

Тинузавър, Велико Търново

Abstract: *Multidisciplinarity is at the core of the STEM approach to learning science, technology, engineering, and mathematics, but this is still misinterpreted, and as a result, different subjects are still taught separately. Mixing them all together presents many challenges to educators. While working on a school agricultural project, many of those challenges were identified and analyzed, and solutions were sought. STEMx, where the "x" stands for extreme multidisciplinarity, implies that all the subjects involved in the educational project must be taught together within the same class, allowing the acquisition of the necessary knowledge and skills while establishing the connection between different sciences using them for solving practical everyday problems. The agricultural project that is used is an automated water drip irrigation unit that takes care of one plant.*

Keywords: *STEM; Multidisciplinary; Agriculture; Curriculum.*

DIGITAL WRITING BOARD IN STRUNIMA

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ДИГИТАЛНА ДЪСКА ЗА ПИСАНЕ В СТРУНИМА

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Abstract: *Some of the properties and components of the digital writing board in StruniMa are presented along with usages in synchronous education – both in present and network-remote environments. Some of the accents are writing on generated 3D objects, saving and opening solutions of mathematical problems and some of the benefits and downsides of digital hand-writing mathematical solutions.*

Keywords: *Digital Drawing Board; 3-dimensional Objects; Mathematical Solution; STEM.*

DEVELOPMENT OF CHILDREN'S FANTASY WITH USING 3D PRINTING

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РАЗВИТИЕ НА ДЕТСКАТА ГАНТАЗИЯ С ПОМОЩТА НА ТРИИЗМЕРНО ПРИНТИРАНЕ

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Abstract: *The introduction of innovations in education is a current topic in Bulgarian educational institutions. 3D printing, as a relatively new technology, is becoming an invariable participant in this process. The 3D printer from technical equipment is transformed into a pedagogical tool stimulating the intellectual and creative development of children.*

Keywords: *3D Printing; Education; 3D Technologies.*

PERMUTATION GAMES. THE DODECAHEDRON PUZZLE

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ПЕРМУТАЦИОННИ ИГРИ. ПЪЗЕЛЪТ ДОДЕКАЕДЪР

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Abstract: *In the talk a mathematical model for the dodecahedron puzzle is presented. This game belongs to the Rubik cube type. The permutation group of the two faces movings is considered. Some formulae are found for ordering the final face, namely for permutation and rotation of the vertices.*

Резюме: *В доклада се представя математически модел на играта от тип „Рубик куб" с форма на додекаедър. Разгледана е групата пермутации, определена от движенията на две от стените. Намерени са формули за подреждане на последната стена – размяна и ротация на върховите елементи.*

THE ROLE AND EFFECTIVENESS OF IMPROVING THE QUALITY OF STUDENT'S EDUCATION OF THE STEM METHOD IN PROFILED HUMANITARIAN HIGH SCHOOL "ST. ST. CYRIL AND METHODIUS" - TOWN OF VELIKO TARNOVO, BULGARIA

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РОЛЯТА И ЕФЕКТИВНОСТТА ЗА ПОВИШАВАНЕ КАЧЕСТВОТО НА ОБУЧЕНИЕ НА УЧЕНИЦИТЕ ЧЕРЕЗ STEM МЕТОДЪТ В ПРОФИЛИРАНА ХУМАНИТАРНА ГИМНАЗИЯ "СВ. СВ. КИРИЛ И МЕТОДИЙ" - ГР. ВЕЛИКО ТЪРНОВО, БЪЛГАРИЯ

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Abstract: *The report describes the forms and methods of education used to improve the quality of education for students at St. st. Cyril and Methodius Profiled Humanitarian High School in Veliko Tarnovo town. Guidelines and good examples are indicated in the STEM idea when working with students from the school with an increased interest in the digital areas of professional and profiled directions in the specialties they have studied in the last few years trough the key role of subjects with directions in IT technologies. Students' creative ideas are described trough realized project approaches on their part. The effect of interest clubs on the increase in learning motivation is discussed, It contains examples of good practices hat led to he participation of students in the National STEM Center – Sofia with their project assignment in competitive forms organized at the national level. Conclusions are structured about the role of effectiveness in increasing the quality of training for trainees in the school.*

Keywords: *Educations; STEM Training; Quality; Periodictable; UT Firm; SEN.*

Резюме: *В доклада се описват форми и методи на обучение, които се използват за повишаване качеството на обучение при учениците от ПХГ „Св. св. Кирил и Методий", гр. Велико Търново. Посочват се насоки и добри примери в СТЕМ идеята при работа с ученици от училището с повишен интерес към*

дигиталните области от професионални и профилирани направления в специалностите, които изучават през последните няколко години чрез ключовата роля на предмети с насоки в ИТ технологии. Описват се ученически креативни идеи чрез реализирани проектни подходи от тяхна страна. Засегнато е влиянието на часовете - клубове по интереси, върху нарастването на мотивацията за учене. Съдържат се примери за добри практики, довели до участие на обучаемите в Националния СТЕМ център – София с тяхно проектно задание в състезателни форми организирани на национално ниво. Структурирани са изводи за ролята ефективността за повишаване качеството на обучение при обучаемите в училището.

Ключови думи: *Образование; СТЕМ обучения; периодична таблица; УТ фирма; СОП.*

THE USE OF 3D PRINTING TECHNOLOGY IN EDUCATION FOR STUDENTS WITH AUTISM SPECTRUM DISORDER – ASSESSMENT OF GOOD PRACTICES

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ИЗПОЛЗВАНЕ НА ТЕХНОЛОГИЯ ЗА 3D ПЕЧАТ В ОБРАЗОВАНИЕТО НА УЧЕНИЦИ С РАЗСТРОЙСТВА ОТ АУТИСТИЧНИЯ СПЕКТЪР - ОЦЕНКА НА ДОБРИ ПРАКТИКИ

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Abstract: *The aim of this paper is to identify several promising practices from the scientific literature of using 3D Printing technology in education for students with Autistic Spectrum Disorder (ASD). Such practices could contribute to the learning, social integration and wellbeing of this group of students. In order to achieve this goal, three research questions are defined. More than 50 relevant articles drawn from Google Scholar and Science Direct are reviewed and 25 of them are selected for analyzing the best practices. 7 of them were identified as fully meeting the study criteria. The analysis is made on the basis of criteria like: type of research, target groups, observed results and challenges as well as used 3D printing technology and software. As a result of this analysis, the answers to the research questions were given in order to define the most efficient practices regarding the application of 3D printing in education of people with ASD.*

Keywords: *3D Printing; ASD; Autism Spectrum Disorder; Education; STEAM.*

FRACTAL MODELS FOR SIMULATING BIOMEDICAL SIGNALS

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ФРАКТАЛНИ МОДЕЛИ ЗА СИМУЛИРАНЕ НА БИОМЕДИЦИНСКИ СИГНАЛИ

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Abstract: *In the article, two fractal models: Fractal Brownian Motion (FBM) and Fractal Gaussian Noise (FGN) for simulating biomedical signals are presented, investigated and analysed. These models reflect the complex and nonlinear dynamics of cardiac activity and may be useful in the study of various cardiovascular diseases and conditions. The main characteristics of biomedical signals, such as self-similarity, fractal dimension, long-term dependence and scale invariance, depend on the Hurst parameter, and its values vary between 0 and 1. If the value of this parameter is between 0.5 and 1.0, then the investigated signal has a positive correlation and shows persistence. Understanding and properly estimating the Hurst parameter can provide important information about the behaviour of complex systems and signals, such as the biomedical signals. In this paper, the FBM is simulated by applying the Random Midpoint Displacement algorithm and the FGN by the Paxson algorithm. A comparative analysis and evaluation of the presented algorithms was made regarding the following two aspects: accuracy of the simulated signals and the required processing time for simulating signals of different lengths. Based on the comparative analysis and evaluation of the presented algorithms, the better algorithm will be determined, which can be used in the study and analysis of real biomedical signals, such as the cardiac signals (RR time series).*

Keywords: *Fractional Brownian Motion (FBM); Fractional Gaussian Noise (FGN); Fractal Process; Hurst Exponent; Random Midpoint Displacement (RMD) Algorithm; Paxson Algorithm.*

MATHEMATICAL TOOLS FOR SIMULATING PHOTOPLETHISMOGRAPHIC SIGNALS

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МАТЕМАТИЧЕСКИ ИНСТРУМЕНТИ ЗА СИМУЛИРАНЕ НА ФОТОПЛЕТИЗМОГРАФСКИ СИГНАЛИ

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Abstract: *The article presents an algorithm for modeling a photoplethysmographic signal using mathematical equations generating the basic waveforms. Photoplethysmographic signals are recorded by sensors recording changes in light intensity and are used in modern scientific research to conduct an effective mathematical analysis of heart rate variability. The article presents the results of conducted studies of the statistical parameters of the synthesized photoplethysmographic signal. The synthesis time of photoplethysmographic series of different lengths was analyzed.*

Keywords: *Sensor; Simulations; Mathematical Analysis.*

In-Depth Methods Review of Neural Network Architectures for Forecasting Heart Rate Time Series Data

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Задълбочен преглед на методите от архитектури на невронни мрежи за прогнозиране на времеви серии от данни на сърдечен ритъм

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Abstract: *The accurate prediction of heart rate is critical for the proactive monitoring and management of cardiovascular health, a leading concern worldwide due to the prevalence of cardiovascular diseases. Traditional time series forecasting methods, such as ARIMA and Prophet, often fall short in addressing the complex, non-linear nature of heart rate data, which is inherently noisy and highly variable. This paper provides a comprehensive review of contemporary neural network architectures that have shown promise in this domain, specifically focusing on Long Short-Term Memory (LSTM) networks, transformer-based models (PatchTST and iTransformer), Tiny Time Mixers (TTMs), MOMENT models, and deep reinforcement learning. We delve into the architectural intricacies of these models, their training processes, and the performance metrics used to evaluate them. Our analysis highlights the unique strengths and limitations of each approach, emphasizing their suitability for heart rate time series forecasting. Through empirical evidence and comparative analysis, we demonstrate that transformer-based models, TTMs, MOMENT models and deep reinforcement learning significantly enhance forecasting accuracy and efficiency over traditional methods. This review aims to provide a detailed understanding of these advanced techniques, offering valuable insights for future research and practical applications in the field of cardiovascular health monitoring.*

Keywords: *Rate Prediction; Time Series Forecasting; Neural Networks; Transformer Models; Long Short-Tem Memory (LSTM); Tiny Time Mixers (TTMs); Deep Reinforcement Learning; Machine Learning; Predictive Modeling; Sequential Data Analysis.*

EMULATING AN ECG WAVE USING A SIMPLE GEOMETRIC PRIMITIVES

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ЕМУЛИРАНЕ НА ЕКГ, ЧРЕЗ ИЗПОЛЗВАНЕ НА ЕЛЕМЕНТАРНИ ГЕОМЕТРИЧНИ ПРИМИТИВИ

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Abstract: *This paper presents an easy to implement algorithm for generating an ECG signal. The shape of the generated signal is idealized. For the base of shape of simulation model the signal obtained from lead 2 was used. The goal is to achieve the realization of a maximally economical method in terms of computing power and energy consumption for obtaining an ECG signal for use for visualization in a portable device.*

Keywords: *ECG; Signal; Emulation; Algorithm; Graphics.*

EXPLORING THE CAPABILITIES AND LIMITATIONS OF CHATGPT FOR PROVIDING NUTRITION-RELATED HEALTH INFORMATION

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ИЗСЛЕДВАНЕ НА ВЪЗМОЖНОСТИТЕ И ОГРАНИЧЕНИЯТА НА CHATGPT ЗА ПРЕДОСТАВЯНЕ НА ЗДРАВНА ИНФОРМАЦИЯ, СВЪРЗАНА С ХРАНЕНЕТО

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Abstract: *The report examines the possibilities and limitations of ChatGPT as a tool for providing nutrition-related health information. The results show that ChatGPT demonstrates significant potential to provide immediate and adequate information related to food and nutrition, offering personalized solutions to nutritional problems at a level equal to and even better than the answers and solutions offered by nutritionists and dietitians. However, the report also points out some limitations and disadvantages of using ChatGPT, namely limitations in integrating the latest scientific findings during its training, as well as the possibility that it may be trained by external sources offering questionable and unverified information, which may lead to low-quality and even health-threatening advice. There is also a high risk to data security and privacy protection when using ChatGPT. These conclusions highlight the need for continuous development and improvements in the system to ensure its optimal efficiency and utility for users.*

Keywords: *Nutrition; Dietary Advice; Healthy Diet.*

ANALYSIS AND PREDICTION OF TIME-SERIES DATA HEART RATE VARIABILITY USING ARIMA MODEL

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АНАЛИЗ И ПРОГНОЗИРАНЕ НА ПРОМЕНЛИВОСТТА НА ВРЕМЕВИТЕ СЕРИИ ОТ ДАННИ НА СЪРДЕЧНАТА ЧЕСТОТА С ПОМОЩТА НА ARIMA МОДЕЛ

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Abstract: *Heart rate variability (HRV) is a critical indicator of cardiovascular health and autonomic nervous system function. Accurate analysis and prediction of HRV can significantly aid in early diagnosis and management of cardiovascular diseases. This study leverages time-series data of heart rate measurements to develop and validate an Autoregressive Integrated Moving Average (ARIMA) model for predicting HRV. The dataset includes daily summaries of heart rate metrics, resting heart rate and detailed breakdowns of time spent in various heart rate zones. By performing descriptive statistics, time series analysis and anomaly detection, we aim to identify patterns and trends in the data. The ARIMA model demonstrates robust performance in forecasting short-term HRV, providing valuable insights into potential cardiovascular events. Our findings highlight the model's potential application in clinical practice for enhanced patient monitoring and timely intervention, improving patient outcomes.*

Keywords: *Heart Rate Variability (HRV); Time-Series Analysis; ARIMA Models; Cardiovascular Health; Predictive Modeling; Data Analytics.*

CHALLENGES FOR EDUCATION USING AI

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ПРЕДИЗВИКАТЕЛСТВА ПРЕД ОБРАЗОВАНИЕТО ПРИ ИЗПОЛЗВАНЕ НА AI

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Abstract: *The main goal of the article is to present the challenges faced by educational institutions, teachers and students themselves in the use of Artificial Intelligence (AI) in the educational process and the possibilities for its applications in the main activities in the field of education, such as e-learning, creating of online and self-training lessons, the acquisition of new skills to use new technological opportunities such as smart learning systems and the protection of shared data in AI-adapted applications. In the article, we will look for answers to the questions - in which areas of education and in what form does artificial intelligence enter; the reasons for entering AI in education; what is the security of personal data when using AI-based tenologies, the advantages and what problems it can solve, why it should be used in education.*

Резюме: *Основната цел на статията е да представи предизвикателствата, пред които са изправени образователните институции, преподавателите и самите ученици при използването на Изкуствения интелект (ИИ) в обучителния процес и възможностите за приложенията му в основните дейности в областта на образованието, като например електронното обучение, създаването на уроци онлайн и такива за самоподготовка, придобиването на нови умения за използване на нови технологични възможности като smart системи за обучение и защитата на споделените данни в приложенията, адаптирани към AI. Определено след навлизането на ИИ в различни области, не само на знанието, но и в обществено-икономическия живот, се създаде една нова дигитална реалност, чието развитие трудно можем да прогнозиране, но и почти невъзможно да спрем като разпространение във всички сфери на света ни. В статията ще отговорим на няколко съществени въпроса, произлизащи от непознаването на ИИ и може би страха за повечето образователни експерти относно внедряването му в учебния процес. Ще потърсим отговори на въпросите - в какви области на образованието и под каква форма навлиза изкуствения интелект; причините за навлизане на AI в*

образованието; каква е сигурността на личните данни при използването на тенологии, базирани на ИИ, предимствата и какви проблеми може да реши, защо да се използва в образованието.

CHALLENGES AND POSSIBLE SOLUTIONS FOR PROMOTION THE LEVEL OF DIGITAL LITERACY AMONG THE MUSEUM COMMUNITY IN BULGARIA

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ПРЕДИЗВИКАТЕЛСТВА И ВЪЗМОЖНИ РЕШЕНИЯ ЗА ПОВИШАВАНЕ НИВОТО НА ДИГИТАЛНА ГРАМОТНОСТ СРЕД МУЗЕЙНАТА ОБЩНОСТ В БЪЛГАРИЯ

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Abstract: *The article examines some of the existing challenges faced by the museum community in Bulgaria regarding the use of various modern tools and technologies in the daily work process. The text also presents some of the potential possibilities for solutions, as well as approaches to increase the level of digital literacy of museum workers in the country, and the results are based on an empirical sociological study conducted on "Digitalization as a factor for the development of museums in Bulgaria", which is held in the period from February 2020 to November 2023.*

Keywords: *Challenges; Digital Literacy; Museums in Bulgaria.*

Резюме: *В статията се разглеждат някои от съществуващите предизвикателства, пред които е изправена музейната общност в България по отношение на използването на различни съвременни средства и технологии в ежедневния работен процес. В текста се представят и някои от потенциалните възможности за решения, както и подходи за повишаване нивото на дигитална грамотност на музейните работници в страната, като резултатите се базират на проведено емпирично социологическо проучване за „Дигитализацията като фактор за развитие на музеите в България", което е проведено в периода от месеците февруари 2020 до ноември 2023 г.*

Ключови думи: *предизвикателства; дигитална грамотност; музеи в България.*

SELF-EFFICACY AND ITS IMPACT: LITERATURE REVIEW IN THE CONTEXT OF THE TEACHING PROFESSION

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АЗ-ЕФЕКТИВНОСТ И НЕЙНОТО ВЪЗДЕЙСТВИЕ: ЛИТЕРАТУРЕН ОБЗОР В КОНТЕКСТА НА УЧИТЕЛСКАТА ПРОФЕСИЯ

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Abstract: *The efficacy of teachers is a crucial and guiding factor in the quality of their work. This literature review examines self-efficacy and its psychological dimensions. The aim of the report is to incorporate the key scientific theories that present self-efficacy and its specific effects on teachers' work. It has a direct impact on how they manage the teaching process in the classroom and create a favorable environment where students are motivated to achieve high results. The review also discusses how teachers' sense of self-efficacy influences their assessment of their own ability to effectively impact student learning and behavior. Self-efficacy was first described in Bandura's theory and refers to an individual's belief in their ability to exercise certain behaviors in order to achieve a goal. This construct is of significant relevance to the work of educational professionals, given its determining role as one of the factors contributing to their professional success and work efficiency.*

Keywords: *Teachers; Self-efficacy; Teaching Profession.*

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http://www.math.bas.bg/vt/stemedu/

http://stemedu.eu/