3rd International STEM Education Conference

Abstract Book

July 2-3, 2022
Istanbul - Turkey

Editor: Assoc. Prof. Hasan Özcan

IBN HALDUN UNIVERSITY

Co-funded by the Erasmus+ Programme of the European Union

STEMkey

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PUSULA 20 TEKNOLOJİ VE YAYINCILIK A.Ş

3rd International STEM Education Conference Abstract Book
ISBN: 978-605-71473-3-2
Publisher Certificate: 56787

Release Date: March 2023

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	Maksim Velichko Vladimir Esin Natalya Zinchenko	STEM Contribution to the Development of Technical Vision Hardware and Software Complex for Concentration Tables	
	Panagiota Argyri	Case studies of innovative learning pathways to STEM	

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	Paulo Jorge Nogueira Torcato	Programming and robot simulators in mathematics teaching	
	Paulo Jorge Nogueira Torcato	Learning mathematics with programming and robots	

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Mathematical Modelling of Slope through Robotics Applications

Mustafa Buğra AKGÜL[1]

Abstract

Experts in mathematics education identify models as tools manipulated in mathematics or statistics to interpret real-world situations (Lesh & Doerr, 2003). Models are among the most important cognitive objectives of mathematics and statistics instruction. Therefore, NCTM (2014) emphasizes the use of representations to model, interpret, and communicate real-world situations. Studies have shown that mathematical modeling presents an alternative approach adequate for solving real-life scenarios that promotes and enhances critical thinking, classroom discourse, and conceptual understanding (Lesh & Zawojewski, 2007; Sriraman & English, 2010; Zawojewski, 2010).

Modeling requires translations between reality and mathematics, where students are challenged to study a situation using models and testing that the solution makes sense in the context of the real-world situation (Swetz & Hartzler, 1991). Pollak (2003) explored deeper into this action, stating that mathematical modeling involves (a) a situation in the real-world, (b) making certain assumptions, (c) utilizing a model to obtain a mathematical formula, and (d) applying mathematical procedures to the formula to achieve reasonable real-world answer. Thus, mathematical modeling is a real-life task, which involves mathematical practices and processes such as critical thinking, high cognitive demand, and communication.

Educational Robotics as a learning tool can encourage students' curiosity and interest by providing students fun and hands-on activities in an attention-grabbing learning environment from kindergarten to college level (Eguchi, 2010). The learning environment that educational robotics provides can enable children to work with real-world problems and interact with their learning setting (Alimisis, 2013). Robotics can increase not only creativity and communication skills, but also increase higher order thinking skills of students. Engaging students in robotics challenges builds innovation, creativity, and problem-solving skills. Since robotics crosses multiple curriculum subjects as done in STEM education, students must learn and apply their knowledge in science, engineering, math, and computer programming. Therefore, students might develop their knowledge, skills and interest in science, math, engineering, and technology through robotics (Rogers, 2003).

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The aim of this study is to examine the effectiveness of robotics (LEGO EV3) which is used as a tool in mathematical modeling activity regarding the concept of slope. This study also aims to explore the mathematical knowledge and skills that middle school students employ during modelling activity, and students' competency in modeling activity using robotics. Another aim of this study is to investigate students' perceptions about the modeling activity guided by educational robotics. Results of this study is expected to indicate that robotics can be utilized efficiently in authentic modeling activity to improve mathematical knowledge and help gaining insight into middle school students' capabilities of engaging in such modeling activity. The result of this study is also expected to show that mathematical modeling activity via robotics is a powerful tool for developing quantitative reasoning, problem-solving skills, and modeling competencies. It is expected that mathematical modeling activity guided by robotics encourages the development of a wide range of mathematical practices and 21st century learning skills that are useful for real-life situations and today's world.

Keywords: STEM education; Mathematical modelling; Robotics; Mathematics Education, Slope

The Sound Waves and Communication System Program for Fostering Integrative STEM Learning and Computational Thinking

Nayif Awad[1]

Abstract

This study presents a new program for the integrated learning of science, technology, engineering, and mathematics (STEM) focusing on promoting interdisciplinary learning and cultivating computational thinking. The research aimed at exploring students' achievements and motivation to learn a complex and challenging subject about sound waves and communication systems. Additionally, it sought to explore students' metacognitive strategies and thinking processes related to problem solving in computerized and digital environments. The participants were 81 junior high-school students (7th and 8th grades, aged 13-14) from different Arab schools in northern Israel. They took a 30-hour course (15 two-hour sessions) that encompassed subjects such as sound and waves, conversion of sound to an electrical signal, amplification, sampling, and analog to digital conversion. Data collection tools included administering a motivation questionnaire and a computational thinking attitude questionnaire pre and post the course, conducting final exams, holding semi-structured interviews with the students, and analyzing their mini-projects. Findings from the final exams and interviews indicated that the students managed to acquire a firm (conceptual) knowledge and they handled the subject matter well. The students also succeeded in developing and presenting final mini-projects while showing a self-efficacy to learn new advanced scientific subjects with minimum teachers' guidance based on the results derived from the motivation questionnaire and interviews with the students. In addition, findings from the computational thinking attitude questionnaire showed that the students' problem-solving and computing skills improved significantly after taking the course. To conclude, the sound waves and communication system program has the potential of contributing to the power of integrative STEM learning environments, and thus, increase students' motivation in terms of self-efficacy and promote their computational thinking skills.

Keywords: Computational thinking; interdisciplinary; sound; STEM

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Teaching Mathematics with Encryption Algorithms from Past to Present

Remzi AKTAY[1]

Abstract

My goal in this project is to prepare a work within the scope of STEM education that is more focused on practice, enabling students to acquire certain learning goals of high school mathematics and computer sciences. Based on the initial question of "Is there an equation that yields side-based right triangles?", the students solve this equation by themselves according to the steps given in the instruction. They can deduce themselves that side-based right triangles are infinite, thanks to this equation by changing its variable. Then, based on this equation, they form spirals compased of triangles. Students can create their own spirals through student practice pages. Then from this spiral, Heron's polygons, especially Heron's triangles, can be formed and these polygons can be divided into two types as "convex" and "concave". Again, on the practice pages allocated to the students, they form their own Heron's polygons in their own spirals. Through spirals, students find a solution of quadratic equations with multiple unknowns based on the side lengths of Heron's polygons. Because they learn that changing the location of unknowns yields different solutions and that they can both get infinite different polygons on the same spiral and create infinite different spirals, they will have learned that these equations have infinite different solutions within the set of integers. In addition, they can form rectangular cuboids whose edges and diagonal lengths are positive natural numbers. There are sample encryptions for students to make traditional encryption algorithms and keyed encryption algorithms, symmetric and asymmetric encryption algorithms, based on the concept of algorithms they learned in computer science at every stage while learning these mathematical outcomes. The teachers can easily apply these encryption practices given in Appendix-1 in the classroom. Again, in each subject, students are given practice sheets for traditional, symmetric and asymmetric encryption. In this way, students will both reinforce their mathematical learning goals by practicing on their own, and will better understand the logic of encryption and decryption by making encryption algorithms. All of these were worked on by students at school and positive feedback was received. Most are works submitted and selected to national and international student project competitions. The benefits of this project for teachers are as follows; 1-)

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Regardless of the conditions of the teachers in any country; only pen, paper, ruler, protractor and calculator are enough for this work. 2-) If the school has the means, students can do the coding and programming of the encryption algorithms by following the instructions in the project. In this way, they can both achieve the relevant mathematics learning goals in a fun way and use these in computer science lessons. 3-) After the teachers have the sample encryptions done, they can have the students practice more by only distribute the application pages to them. 4-) If desired, this work can be done in the classroom or by creating a study group. A study group can also be formed with outside support, especially with other students who know coding and programming. In this way, the students learn technology, programming and mathematics together. 5-) The most important feature of this study is that students can understand that mathematics is the most important component in coding and programming. Students can see that mathematics isn't an abstract science, but has applications in daily life. 6-) At the end of this study, students will see that traditional and keyed encryption algorithms can be created from each of the mathematical topics, as well as more complex encryption algorithms can be created by combining different topics and they can practice themselves.

Keywords: STEAM Project; creative thinking; cooperation; robotics; innovative technologies

Methodology of STEAM Education in the Prism of Pedagogical Science

Ulkar Mirzaliyeva[1], Iqrar Nazarov[2]

Abstract

The education system today is undergoing changes aimed at humanizing the learning process and changing the role of the teacher and the student. The teacher is no longer only a carrier and transmitter of scientific information, but also the organizer of the cognitive activities of students, their independent work, and scientific creativity. The main goal of his activity is to create conditions for the development of the creative personality, on which it is necessary to spend incommensurably more strength and skills than on the formation of knowledge, skills, and experience. At the same time, the current situation requires from professionals: • a developed need for continuous professional self-education and self-development; • the ability to work with professional information and construct new knowledge; • communicative competence, which implies an individual style of communication, mastery of speech and non-verbal way of expression, ability to resolve conflicts. All the above corresponds to the functional structure of the teacher's activity, including gnoseological, organizational, constructive, and communicative skills. (Pedagogical game technicians: a set of methods and exercises / L. S. Kozhukhovskaya, and others; under total ed. L. S. Kozhukhovskaya. - Minsk: Ed. BSU center, 2010. — 233 c.) Effective pedagogical strategies can be seen as objective–oriented activities and the flow of information between teachers and students. Studies of teaching methods influence all types of learning in the cognitive, affective, and psychomotor domains as Eila, Irmeli and Eija cited in (Karami, Pakmehr, and Adhili, 2012). The choice of effective teaching methods depends on what kind of teaching approach is preferred. An effective teacher has a wide-ranging repertoire of different teaching and learning models, strategies, and techniques and knows how to create the right conditions for learning. (Pedagogical Approaches and Effective Teaching in Biology Education: A Review of Teacher's Roles and Responsibilities, ATBU, Journal of Science, Technology & Education (JOSTE); Vol. 6 (4), December 2018)

Understanding the historical experience of mankind in the field of education and training the younger

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generation helps the student-teacher to realize the significance of the individual style of work of the teacher with students, to understand that his activities cannot be limited to simply following a set of prescription recommendations, no matter whoever they come from. There is reason to argue that it is historical and pedagogical education that allows a modern teacher to better navigate the variety of ideas and approaches that existed and exist in pedagogical science and educational practice. Historical and pedagogical knowledge helps both the future teacher and the teacher-practitioner in understanding professional and pedagogical activities as such and their views on them. Together with the whole society, pedagogical science and pedagogical practice participate in the reassessment past and attempts to predict the future with it in mind. In such a challenging environment, the historical and pedagogical knowledge allows a thinking teacher to act sensibly in modern conditions, given the future. (History of pedagogy and education from the birth of education in primitive society until the end of the 20th century. Tutorial for pedagogical educational institutions. Under the editorship of Academician RAO A.I. PISKUNOV)

Most of the research preceding the experimental part was important to dedicate to the study of works in pedagogical science, both classics, and modern researchers. On the one hand, the existing experience of using design methods in education was studied. The results allowed us to create our understanding and vision of the main requirements for future research. The experience of contemporaries is being studied, which gives a vision of the situation in terms of the pedagogical realities of our time.

Keywords: STEAM metodology; effective pedagogical strategies; historical experience; pedagogical science.

Applications of Mathematical Modeling with GeoGebra for STEM

Ilyas Karadeniz[1]

Abstract

GeoGebra is a free dynamic mathematics software, which is a very useful tool to introduce STEM in all levels of education. The name of GeoGebra comes from the association of Geometry with Algebra. It is possible to apply Graphing, CAS, Geometry, 3D Graphics, Spreadsheets, and Probability with GeoGebra because of the perspectives the software presents. GeoGebra's features and tools are convenient to use the software for STEM and mathematical modeling. Demonstration, exploration, modeling, experimental work, and creation are some possible ways to use GeoGebra in education. These are very important in terms of applications of STEM principles. The software is beneficial for mathematics education aspects because of multiple display options to represent and analyze different cases quickly. Therefore, users are able to explore and understand mathematical concepts and the connections by investigation. It is also possible to share and use the materials created by other users in GeoGebra. Users are able to enhance their skills such as corporation and communication in other disciplines as well as mathematics.

The aim of this study is to investigate pre-service mathematics teachers' ideas of using GeoGebra for mathematical modeling in STEM activities. The theoretical information about mathematical modeling was given at the beginning of the semester in the Mathematical Modeling course, which is a core senior-level course in mathematics education. GeoGebra software was introduced and the tools of the software were explained in the following weeks. The pre-service teachers were also allowed to use GeoGebra to experience the applications of the software in a computer lab during the semester. I have presented STEM activities and guided pre-service teachers to create a mathematical modeling for these activities by using technology as the course instructor. Pre-service teachers were assigned to find a STEM activity and create a mathematical modeling solution for this activity with technology. In addition, they also were assigned to create a solution for bouncing ball activity in GeoGebra. The data collected from 56 senior pre-service mathematics teachers with a five-Likert scale questionnaire and six participants were interviewed about using GeoGebra for mathematical modeling. This study has suggestions for mathematics educators, in-service and pre-service mathematics teachers.

Keywords: Technology; STEM Activity; Pre-service Mathematics Teachers

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STEMkey: Teaching standard STEM topics with a key competence approach

Gültekin Cakmakci[1], Andrej Sorgo[2]

Abstract

Description The EU-funded project STEMkey ('Teaching standard STEM topics with a key competence approach', 2020-2023) enables future STEM teachers to refrain from teaching with the sole purpose of knowledge-transfer of a single STEM subject. This simply does not measure up to todays and tomorrows challenges anymore. Instead, STEM teachers will learn how to nurture their students' key competences when delivering standard STEM content, which means to deliver subject knowledge and allow the development of skills and attitudes to use this knowledge in various societal and real-life contexts in equal measure. One part of the solution is to train future teachers in "being STEM key competent". They need to understand the relation between knowledge, skills and attitudes, how they affect each other and how they have an effect on their students' learning experience and personal life.

12 Higher Education Institutions from as many countries are working on the STEMkey project to provide you with practice-ready material (activities, background information and guidelines) involving latest STEM education research: competence-based, real-life embedded and interdisciplinary.

- Module 1: Introduction and Guidance into the EU's Key Competence Framework and how you can transform your standard STEM topics into powerful learning experiences

Explaining the interdisciplinary STEM key competence approach for exemplary standard topics from each STEM discipline:

- Module 2: Functions
- Module 3: Measurement
- Module 4: Human Anatomy and Physiology
- Module 5: Material Cycles

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- Module 6: Chemical reactions
- Module 7: Periodic Table
- Module 8: Electricity
- Module 9: Light
- Module 10: Household Appliances
- Module 11: Technical Materials
- Module 12: Algorithms and Data

Become a module developer yourself:

- Module 13: Support Kit to support Higher Education teaching staff in 1) using IO2-IO12 in practice, as well as 2) developing further HE modules on any given standard topic

Keywords: Key competences; STEMkey; STEM Education

STEAM Approach to Implementing Neuroscience in Psychology and Education

Anna Budarina, Olesya Parakhina, Ksenia Degtyarenko[1]

Abstract

The implementation of cutting-edge issues in the system of higher education worldwide has led to the search for new forms and priorities for research and development in order to increase the scientific and educational potential of higher educational establishments to create new technologies, industries, and competitive products, integrate university research, expand inter-institutional networking within the regional, national and international social and educational systems.

The research examines the best practices of the Institute for Education and the Humanities, one of the largest structural divisions of the Immanuel Kant Baltic Federal University (IKFBU), that forms the "core" of the regional ecosystem of psychological and pedagogical education in the field of Neuroscience.

The aim of the study is to analyze the IKBFU experience of implementing STEAM approach in the field of Neuroscience in Education and Psychology, to present a description of the project, the conditions for its implementation and the results, the performance indicators of the project implementation and their significance, and to identify the positive effects of the project in the field of Neurocognitive Sciences, that ensure the development of a regional social and educational ecosystem in the framework of global educational agenda.

Research methods comprise analysis of results and modeling of development prospects and implementation of best practices, experience dissemination to other regions; reflexive-system analysis of the justified organization of pedagogical activities, taking into account the effects obtained from the results of the project implementation.

The conducted research allows to draw a conclusion about the strategic effectiveness of the implemented STEAM approach to the project at three levels: at the university level, at the regional level, at the national level, including the creation of a laboratory base that provides informative, material and technical platform for the implementation of the research conducted within the internship of Master's Degree

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students; the identification of new promising areas for training, retraining and advanced training of the faculty members involved in the implementation of the educational programme "Neuroscience"; increasing the quality of educational and research activities within the framework of the international educational programmes on Neuroscience in Education and Psychology; the modernization of the system for pre-service teacher training in the field of Neuroscience; the involvement of leading scientists in the implementation of educational programmes; ensuring the integration of science and education; attracting talented youth to the field of science and innovation; creating conditions for increasing the prestige of research and teaching activities; the modernization of the system for pre-service teacher training in the field of Neuroscience in terms of optimizing the content of educational programmes, internship and bringing the competencies of graduates in line with modern requirements; the promotion of the outcomes of university scientific and innovative activities; establishing sustainable partnerships with industrial organizations in terms of internships for undergraduates; joint implementation of innovative activities in the educational, scientific and industrial fields; development of an experimental and laboratory base for its joint use by scientists, faculty, students, postgraduate students of the university and the representatives of the industry community; pre-service teacher training to meet modern requirements within the subject area of "Neuroscience"; building scientific and educational teams to solve fundamental and applied research priority problems in the field of Neuroscience; the launch of joint laboratory research in focused collaboration with leading enterprises and research centers as well as educational institutions worldwide; the integration of leading expert experience and expertise in the field of Neuroscience to achieve the breakthrough scientific results; the development of priority integrated areas of STEAM education in the field of Neuropsychology, Neurolinguistics, Neurocognitivistics, Neuropsychiatry, Rehabilitation, Neuroclimatology, Machine Learning and Artificial Intelligence.

The results of the study can be used for designing a portfolio of effective and innovative educational programmes that comply with the core areas of the university development and the priority areas of modernization and technological development of the economy; for designing and implementing effective forms of educational activities in the higher education system; for designing educational programmes that meet the individual characteristics and students' needs ultimately leading to the improvement of the quality of life, and the level of satisfaction in the framework of lifelong learning and wellbeing.

Keywords: STEAM-practices; higher education; STEAM approach; Neuro Sciences; Neuro Psychology; Teacher Education; Teacher Training

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A Smart School Systems: A School Community Project

Mehmet Yıldız[1], *Gokhan Kaya*[2]

Abstract

This study is about the school community project which we carry out with students in the MOST project. Our aim in this school community project was to make our school smart in terms of energy efficiency by investigating the suitability of many innovative home systems we use in our homes in schools. We determined two research questions "What can smart school systems include?" and "What can we do to make our school smart?".

First of all, we discussed and researched what could be considered a smart home system in our homes with children. After this preliminary information-gathering stage, we searched for information about what it means for a system to be intelligent. As a result of our research, we can use sensors. We created some questions about these sensors and smart systems. We held an online meeting with an electrical and electronics expert to plan the research process. We first talked about what we were doing and summarized what we wanted to research in this meeting. Afterward, we asked the expert questions and got ideas from the questions in our minds. After this stage, we discussed how the process could be, and as the project leader, we developed a joint action plan with the students and the expert. Based on this action plan, we researched which systems we would integrate with the temperature sensor, timer, sound sensor, and light sensor. As a result of the research, we designed a model school system. Then we completed the soldering of the sensors and components and connected them with the sample tools. As a result, we have seen how sensors are used to design intelligent systems and how sensors save energy. We have developed promising prototypes for the use of sensors at our school.

Keywords: MOST Project, smart systems, sensors, school and society

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Diyarbakır Stem Coordination Center Activities and Good Practices

Yakup TOPRAK[1], Burcu BİLGİÇ UÇAK[2]

Abstract

The education systems of our age prepare their programs to raise individuals who can solve problems, have advanced analytical skills, think critically, and are productive. For this reason, it is inevitable to include new educational approaches and practices in the education curriculum.

The STEM approach is an interdisciplinary learning way that tries to provide the skills and competencies needed today. STEM education is the teaching of science, technology, engineering, and mathematics with an interdisciplinary method (Çolakoğlu & Günay-Gökben, 2017). This approach covers the whole process from preschool to higher education. Integrating existing disciplines with engineering and technology, aimed to ensure the applicability of knowledge in real life, arouse curiosity about the development of problem-solving techniques, and encourage research and creativity.

Countries are in a race for appropriate approaches and successful implementation of STEM education in schools (Thomas &Watters, 2015). For this purpose, the requirements of STEM education have been revealed in the "STEM Education Report" of the Ministry of National Education, General Directorate of Innovation and Educational Technologies and the "STEM Needs in Turkey Towards 2023" reports of TÜSİAD.

The aim of this study is to share the feasibility report, student and teacher selection criteria, sample lesson plans, 2021-2025 strategic goals, and objectives of the STEM Coordination Center, which was founded in 2021 under the Diyarbakır Provincial Directorate of National Education and continues its activities as an outdoor learning environment. "Diyarbakır STEM and Science Center Feasibility Report" was published in 2019 as a research on a STEM and Science Center in Diyarbakır, within the framework of the center's objectives, its relevance, and suitability with national and regional plan programs, needs, reasons, the situation of the region, physical, technical, hardware, social and economic analysis. Following this report, the "STEM Coordination Center and Design&Skills Classes" project was implemented with the financial support of the Ministry of Industry and Technology and

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Diyarbakır Metropolitan Municipality. With this project, a STEM Center was founded in the city center and 16 design skill classes were founded in 16 districts. The aim here is to create a coordination center that will make the workshops founded with different resources at schools functional and active and support innovative education. A roadmap was determined to reveal the short and long-term goals and 5-year action plan of the STEM Coordination Center, practical and realistic goals were determined by holding different meetings with academics working in this field. At the end of these studies, the "2021-2025 Strategic Plan" was prepared for the STEM Coordination Center based on world examples.

Keywords: STEM Coordination Center, Design Skills Workshops, Interdisciplinary Education, Strategic Plan

Workshop: Coding with TI (Texas Instruments) tools

Bahadır Altıntas[1], Orhan Curaoğlu[2]

Abstract

90 minutes session delivered in one day to help participants through extra-curricular sessions on coding

Broad Intended Learning Outcomes

- Know what motivates and what does not motivate young people in coding!
- Able to use microprocessors for feedback and control
- Able to control lights using a microprocessor.
- Able to control a typical robot.
- Know how to develop algorithms into programs.
- Know the features of computational thinking.

1. Using TI Innovator Hub
    a) Exploring the TI Innovator Hub
    b) For loops
2. Control with the TI Innovator Hub and the TI Rover
    a) Exploring sensors to provide feedback.
    b) Using the microprocessor to control a robot.
3. Coordinates and geometry with the TI Rover
    a) Using the Rover's sensors to see and measure
    b) Using coordinates to control the Rover and track its movements.

A rough breakdown of each activity within each session flows on the next page.

Keywords: Coding; STEM; Texas Instruments Calculators

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Indispensable Skills in Distant Education

Mehmet KARABULUT[1], Zafer SONEL[2], Fadime ÖZEN[3]

Abstract

This project was carried out to solve the problem of 'inadequate digital skills of teachers and students in distance education during the pandemic period' and developing students' critical, creative thinking, collaboration. The inevitable need for distance education materials, the insufficient use of web 2.0 tools, and low coding skills were the main problems being tried to overcome with this project. Since the project was multidisciplinary (English, B.I.T. and chemistry), the general achievements of the English course; students are encouraged to participate in task-based, collaborative and project-based language activities; For the B.I.T course, students; add an audio, video, table and graph from the computer to the slide; For the chemistry course, students can organize, present, report and share in accordance with the symbolic language of chemistry and scientific content with the knowledge they have acquired using information technologies; learning such gains has been provided. 85 students from different countries, cities, high schools involved in the project. The main activities of this project are preparing digital presentations, animations, group coding activities, virtual exhibitions with AR&VR, the animated digital book, the usage videos of some certain web 2.0 tools. Evaluation scale and data collection tools like pre-post surveys were used to determine the level of achievement of the goals. At the end of the project, the level of students' attainment of the curriculum achievements was measured with web 2.0 tools. During the project process, the students improved their learning to learn skills by learning the necessary digital information on their own with the activities of introducing web 2.0 tools. With the video feedbacks prepared by the students, it is understood that the students noticed the place and importance of their country among the countries of the world, the cultural riches at the level of our country, and different cultures at the international level. During the project, the students used various innovative digital tools to enhance their creativity and collaboration. In the project, the joint products such as project calendar, coded virtual exhibition, joint coding activities, project final video,

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animated book were done by the students in groups. Presentations of web 2.0 tools have improved their creative thinking and entrepreneurial skills. The results of the project were effective so it was started to be implemented by other group teachers in the project schools. The project reached wider people by publishing it on the school website, magazine news, project blog page, Facebook group, and by presenting it through online meetings. At the end of the project, it was revealed that the digital knowledge and skills of the teachers involved in the project improved, based on the data obtained with the pre and post survey measurement tools. Based on the implementation process of the project and the results obtained, this application can be recommended as an exemplary application for other schools, as the academic and social success of students whose digital competencies increase.

Keywords: Digital skills; creative thinking; cooperation; innovative technologies

Determining the Quality of Argument of Pre-Service Science Teachers through the Media Coverage of the Covid-19 Pandemic

R. Elif Uzun[1], Metin Sardag[2], Gültekin Çakmakcı[3]

Abstract

A key emphasis in the Next Generation Science Standards (NGSS) is for students not to be equipped with only knowledge but to have the ability to produce knowledge. According to this framework provided by NGSS, one of the eight practices of science and engineering was defined as "Engaging in argument from evidence" (the NGSS Lead States 2013). Which is, producing strong scientific arguments supported by scientific elements against socio-scientific issues (SSI) is also a desirable skill for students. In this approach, students should be the centerpiece of the curriculum and teachers should be competent enough to provide students the skills such as encouraging them to attend scientific arguments. However, studies have indicated that pre-service science teachers have insufficient argumentation skills to construct and evaluate scientific arguments. (Aydeniz & Deniz 2013; Gürel & Erol 2017; Martín-Gámez & Erduran 2018). This situation might negatively affect their future science teaching. In this context, it might be said that there should be some certain university education programs in which pre-service teachers can gain desired argumentation skills. The concept of argumentation should not be considered as a concept that should be handled only in the classroom. Individuals also need these skills to be involved in social discussions and critically evaluate science news texts in the mass media and question their validity and reliability. To accomplish this desire, an evaluation rubric was developed to teach PSTs how to analyze a scientific news text on a socio-scientific issue. The coronavirus pandemic was chosen as an SSI for this research. The main focus of this study was to discover "how are the PSTs' skills in using the Toulmin Argumentation Pattern (TAP) they used while creating their own scientific news texts about Covid-19?". After PSTs were given a training about TAP and science journalism, they were expected to write their own news text in groups. The designed rubric was introduced to the participants, and they were informed that their written arguments would be evaluated according to

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this rubric. Four activities were conducted through the four weeks. The results indicated that PSTs' written argumentation skills could be enhanced with these designed activities and the rubric. It was determined that towards the last activities, the number of argument components at the "excellent" level increased, while those at the "unacceptable" level decreased. It was observed that the PSTs' ability to use five (claim, data, warrant, backing, and qualifier) of the six components of Toulmin in their written arguments increased. On the other hand, it was determined that they had difficulties in understanding and using the "rebuttal" element.

Keywords: Argumentation, Toulmin's argumentation model; Covid-19 pandemic; Science news; Pre-service science teachers

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Examining the Flipped Learning Approach in Distance Education Process

Hülya Gür[1]

Abstract

The aim of this study is to reveal the level of recognition and use of Web 2.0 tools used to facilitate the flipped learning approach and teaching methods, which are becoming widespread in distance education processes today. The following research questions were sought in the study: What information do lecturers have about the flipped learning approach to learning? In the distance education processes of lecturers; applying the flipped learning approach; Their own competencies in this area, as well as their knowledge of Web 2.0 tools, and how and for what purpose and how they effectively use them in their lessons were investigated. Covid19 Pandemic in Turkey as a result of the pandemic in other countries has also been necessary to distance education process instead of face-to-face training. In this context, it is important to examine in detail the situation in the distance education process of the lecturers at universities about the flipped learning approach widely adopted in distance education processes and the Web 2.0 tools used. This research is mixed method research in which quantitative and qualitative research methods are used together. In the quantitative phase of the research, the scanning model was adopted, and the case study method was adopted in the qualitative phase. In the quantitative dimension of the study, a sample of 58 mathematics educators was determined using the probabilistic sampling method. The participants of the qualitative dimension of the sample consist of 6 mathematics educators selected by purposeful sampling method among the mathematics educators in the study group formed in the quantitative dimension. The data of the research were collected online via google forms and via e-mail due to the Covid-19 pandemic process. Qualitative data were collected with a questionnaire form prepared by the researchers and consisting of 8 open-ended questions. It has been analyzed using themes and codes. Findings are presented by frequency and direct quotations. They stated that the lecturers tried to use the inverted teaching method, but they could not get enough efficiency because their class sizes were crowded, and they used most of the web 2.0 tools very effectively in their lessons. They also stated that their students were willing to use web 2.0 tools.

Keywords: Flipped learning; Web 2.0 tools; Distance education; Mathematics education; Instructors.

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Bicycle Safety System for Sustainable Transportation

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Abstract

Decreasing the rate of increase of Carbon dioxide gases surfacing from the usage of motorized vehicles will help reduce the global warming. Due to this reason, the importance of using vehicles powered by renewable energy is rising every year. Bicycle is one of these vehicles. After accidents that have occurred because of speeding, the rider may become frightened and turn away from the bicycle, quit using a bicycle for a long time, or may experience traumas that cause the rider to stop cycling altogether. In this study, we have designed a device that will prevent the accidents that may occur with using the bicycle with high speeds and the consequences that may occur after. The device will help any new drivers, especially children. It will allow children to love riding a bicycle, will make sure that they are driving safely without fear and will lower the risk of being injured. This device will alarm the user when the user reaches dangerous speeds. With the alarm, the user will be reminded that they have to slow down. In the making of this device, we used a magnet, a reed relay, an Arduino Uno and a buzzer. We wrote the code and the device algorithm. A 28 inch bicycle has been used for testing. First, the magnet has been fastened to the bicycles wheel. Then, we connected the coded Arduino with the reed relay. After that, we spun the wheel 5 mm away from the reed relay. Every time the magnet passed the reed relay has been calculated as 1 turn. With this information, the Arduino calculated the amount of turns per unit of time thus calculating the speed of the bicycle. When the given value of 25 km/h was exceeded, the buzzer started to make noise to alert the user. The device worked according to plan.

Keywords: Sustainable transportation; global warming; carbon footprint

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Biocars: A Way towards Sustainable Transportation

Sandra Porto Ferreira[1]

Abstract

The STE(A)M integration in schools has a strategic vision in the formation of the students, gives rise to education to promote activities that lead to the development of critical and creative thinking, making us citizens capable of identifying problems and participating in the construction of solutions. In the present narrative, we develop a didactic sequence (DS) with STE(A)M interdisciplinary approach in a 3rd grade class of the primary school. The main goal was to potentiate literacy (scientific and numerical) and critical and creative thinking development in an integrative STE(A)M approach. From this approach, we established the realization of an experimental activity, where the students test construction variables of the biocar without motor through a ramp in work groups to develop an optimized prototype of a biocar without motor. Posteriorly, they participated in a race. The problem question (thematic) is part of the students' daily life, it was intended to develop a variety of subjects of the 3rd grade and the activity presented allowed choices. The students took the opportunity to formulate a hypothesis, experiment, analyze, investigate, optimize, evaluate and reformulate strategies during the research activity, being the teacher a mediator only. With this proposal, the DS tried to develop the considered competences of the 21st century, like collaboration, work developed in groups, critical and creative thinking, anticipate the results, acting and reflecting on the choices made, having in consideration the final result and the communication.

The students are invited to organize their own biocar without motor race, with original cars made by themselves. Moura (2020), refers that "it is possible that students keep motivated (…) by developing creative learning through active methodologies". The construction of the biocar without motor is funny, but also stimulating because the students need to find out what they must build for this to reach the end of the ramp, traveling the greatest distance possible.

The culmination of this activity and its fundamental goal is "to create a biocar without motor that travels the greatest distance possible", considering that, in the first phase, the challenge is the mobility of the biocar without motor. For that, it is necessary to control a variable each time to investigate the distance that the biocar without motor can reach and test a condition (for example, slope variation) several times. We should let the students do their own choices.

Keywords: STEAM; biocar; 21st Century Skills

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Representation of Nature of Science in Science Textbooks: Science, Engineering and Entrepreneurship Applications

Beyza Okan[1]& Ebru Kaya[2]

Abstract

This paper presents how science, engineering, and entrepreneurship (SEE) sections in middle school science textbooks (5th, 6th, 7th, and 8th grade) represent nature of science (NOS). The theoretical background of this study is Reconceptualized Family Resemblance Approach to NOS (RFN) (Erduran & Dagher, 2014; Kaya & Erduran, 2016) which is one of the approaches defining nature of science (NOS). The textbooks were analysed through content analysis. SEE sections were traced based on RFN categories which are aims and values (AV), scientific practices (SP), methods and methodological rules (M), scientific knowledge (SK), professional activities (PA), social certification and dissemination (SCD), social values (SV), scientific ethos (SE), social organizations and interactions (SOI), financial systems (FS) and political power structures (PPS). The findings showed that the SEE sections in science textbooks do not represent RFN categories in a balanced way and some of the categories are missing in the chapters. In the 5th grade science textbook scientific research process and engineering design process are given step by step. There are only a few references for M, SCD and SP in the introductory and activity SEE sections. In the introductory SEE section of 6th grade science textbook there are some references for SP and M with some misconceptions. Otherwise, there is explicit link between scientists and students for SCD. In the SEE activities sections, there are some references for SP, SK and SCD. However, all activities use similar language and similar steps without any articulation in 5th and 6th grade textbooks. In the 7th grade science textbook, there are some references for SP, SK and SCD. Also, in this textbook the life of Turkish scientist is given with some references to PA, FS, SV implicitly. However, SEE activities throughout the units include only engineering activities such as designing telescope. In the 8th grade science textbook, there is no introductory SEE section but after each unit there is one example from history of science and engineering design loop. In those stories, there are some AV, SP, M, SK, PA, SCD, SOI references implicitly. In general, although NOS has never

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been explicitly emphasized, there are some categories that are implicitly given. However, some social categories such as FS, PPS, SOI, SE and SV were almost never found. Briefly, it can be said that SEE sections are very missing to represent the NOS categories defined by RFN. SEE chapters should include explicit and implicit references to NOS in SEE sections by emphasizing all categories of RFN in a balanced way for teaching and learning NOS.

Keywords: Science, engineering, entrepreneurship applications; science textbooks; family resemblance approach

Views of Science Education Graduate Students on Foreign Language-Stem (FI-Stem)

Sümeyra YILMAZ[1], Merve VEZİR[2], Bülent AYDOĞDU[3]

Abstract

This research aims to reveal in depth the views of science education graduate students about the integration of foreign language into STEM. In this study, the phenomenology design was adopted. Being a graduate student in the field of science education and having received STEM education before were determined as criteria as part of criterion sampling. The study group consists of three male and seven female participants, a total of 10 graduate students. One of the researchers conducted semi-structured interviews with each graduate student, individually. After transcribing the interviews, two researchers analysed the data. "Integrating a Foreign Language into Stem," "Science Subjects That Foreign Language Can Be Integrated," "Conditions For Integrating Foreign Language Into Stem," "Advantages of Integrating Foreign Language Into Stem," "Disadvantages Of Integrating A Foreign Language Into Stem," "Stages Of Using A Foreign Language In Stem"; A total of six categories were emerged. When the findings were examined, most participants stated that their foreign language self-efficacy was low. Half of the participants emphasized that it is necessary to integrate the foreign language into STEM, while two participants stated that it is partially necessary, and three participants stated that it is not necessary. Although five participants said it was necessary, they expressed their doubts about how this process would take place. One of the participants stated that a foreign language could not be integrated into STEM because of the nature of the foreign language. Although the participants talk about the contribution of the language as it will improve when a foreign language is integrated into STEM, it is noteworthy that they emphasize its disadvantages more. This can be explained by the fact that the participants do not have sufficient knowledge and equipment on how to integrate a foreign language. Most participants stated that a foreign language could be integrated into STEM with the entrepreneurship and marketing dimensions. At this stage, it was emphasized that

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students' speaking skills could be improved within the scope of language. The participants stressed only speaking and reading among their language skills. They stated that the participants did not consider their writing and listening skills in integrating a foreign language into STEM and that they could use the foreign language mostly during the introduction and deepening phases of the course. The participants stated that for integrating a foreign language into STEM, the most important condition is the cooperation with foreign language teachers. The participants stated that they needed training. The teachers currently working explained through their experiences that the background of the students is important. Unemployed teachers stated that the necessary conditions could be easily met. Yet, working teachers stated that the desired results might not be realized and might even result in misconceptions among students. The same topic can be supported by a study involving English teachers. Focus group interviews with English, Science and Mathematics teachers can be conducted. Training from the field experts in different disciplines can increase the competence of teachers on the subject.

Keywords: FL-STEM; integration foreign language; English teachers; science education graduate students; graduate students

STEM key- Module 10: Integrating Engineering Practices in Education

Gultekin Cakmakci [1]

Abstract

The EU-funded project STEMkey ('Teaching standard STEM topics with a key competence approach', 2020-2023) will enable future STEM teachers to refrain from teaching with the sole purpose of knowledge-transfer of a single STEM subject. This simply does not measure up to todays and tomorrows challenges anymore. Instead, STEM teachers will learn how to nurture their students' key competences when delivering standard STEM content, which means to deliver subject knowledge and allow the development of skills and attitudes to use this knowledge in various societal and real-life contexts in equal measure. Within the project 12 modules have been developed and one of which related to engineering education. Children's first experiences with technology happen at home. Although such a rich context offers a lot to teach important features of engineering, they are not often used as a context in the curriculum, even less so in a hands-on manner. Household appliances are a standard topic of engineering, offering a vast field of practical application examples. This module explores ways of incorporating engineering concepts and practices into STEM education in the context of household appliances.

Keywords: Key competences; STEM Key; STEM Education

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STEM Based Back to Nature eTwinning project

Mirvari Shukurova [1]

Abstract

Due to the increase in world population and changes in consumption habits, our natural resources are decreasing day by day. At the same time, one of the biggest problems of the current century is global warming and the global climate change that is developing in connection with it., to protect both nature and resources, save energy, reduce the amount of waste and. In addition to the activities, our project aims to make the students aware of the environment and be careful by doing a first things that come to mind when you think of recycling materials are:

What we know: paper, metal, glass bottles plastic

What we don't know: Aluminum, copper, iron, concrete, organic waste, batteries, motor oil, accumulators, textile products, wood and some electronic devices

As we know, there is no country in the world that does not experience the severe effects of climate change. Global warming seriously affects people's lives. Article 13 of the Sustainable Development Goals draws attention to the fight against climate change.

Based on all these, in addition to the development of students as more conscious, environmentally friendly and sensitive individuals, the project aims to develop students as mathematical, design-oriented thinking a,nd creative individuals.

The project plays an important role in the development of students' 21st century skills. As we know, 21st century students should acquire skills such as problem solving, instant decision making, and design. In the project, children both look for ways to protect nature and find renewable and sustainable energy In addition to all these, children experience the pleasure of designing products that are beneficial to nature by recycling materials they know as waste.

Children learn to make compost from food waste, make artistic products from waste paper (eg: making origami learn to design bird nests, pencil holders, baskets and other products from cardboard boxes.

Waste paper – accepted as a raw material in the recycling cycle. Paper is also the easiest material to

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recycle in terms of applicability. By adding one ton of paper to the pulp, 8 trees can be prevented from being cut down. Re-manufacturing of used paper reduces air pollution by 74-94 %, water p In addition to all these, students learn to plant seedlings. By watering the seedlings they planted every day, they realize how long it takes for a seedling to grow and at the same time, how important it is for nature to protect the seedlings and forests they planted. Individuals with creative and problem-solving skills as they grow.

In addition to all these, students learn to plant seedlings. By watering the seedlings they planted every day, they realize how long it takes for a seedling to grow and at the same time, how important it is for nature to protect the seedlings and forests they planted. Individuals with creative and problem-solving skills as they grow.

Keywords: Natura project; 21st century skills. materials

A Multidimensional Support Project for STEM Teachers: 3C4Life

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Abstract

The 3C4Life project (Perspectives for Lifelong STEM Teaching – Career Guidance, Collaborative Practice, and Competence Development), funded by the European Commission, aims to make the teaching profession attractive to meet the teacher needs in European countries. The 3C4Life project is an Erasmus+ project to be carried out between 2021 and 2024, with 12 stakeholders from 6 European countries as project partners.

Europe is facing a shortage of teachers in STEM (Science, Technology, Engineering, and Mathematics). Individuals no longer see teaching as an attractive career option can be expressed as the main reason for this situation. This situation will lead to a decrease in the number of teachers in these fields in the long run. Besides that, teachers need to develop their teaching skills and competencies, have experience working in the digital environment, and at the same time ensure their individual development. That is why, recently, teachers are expected to rapidly improve their competencies, digital media activities, and personal development.

Nevertheless, it should not be forgotten that the best performance depends on well-organized conditions. In this context, it is essential to support the professional development conditions of teachers. We are developing a fully digital STEM teacher platform with an innovative professional development approach as part of this project. The project is an all-digital STEM teacher platform with innovative occupational advancement concepts. Its key innovative features are (i) a sequential process of motivational triggers, from low threshold attraction to shared advancement, (ii) a multi-directional variety of vertical and horizontal occupational advancement perspectives unfolded at a glance, and (iii) enhancement-propellant collaboration through Communities of Practice.

Thanks to this platform, all STEM teachers in Europe will find possible ways for their career development

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to develop their competencies (for example, STEM contexts in the classroom, inquiry-based learning, socio-scientific issues, context for STEM activities), international teacher cooperation, and sharing opportunities. We believe that teachers who have lost their ties to the education life at the university and feel alone in the profession will improve themselves and find the support they need through this platform.

Keywords: Career development; STEM teaching, cooperation; in-service support

Parent's Perception of Creating a STEM Model For The Education Of Primary School Students In The Albanian-Speaking Region

Besmal Memedi[1], Ramadan Aliti[2], Bashkim Ziberi[2]

Abstract

STEM education in the Albanian-speaking region is a new concept, without proper organization and policies for support and development. In order to build a successful and appropriate model for STEM education at the level of the Albanian-speaking region in North Macedonia, the six-month activity (February - July 2021) of the Center for Education and Innovative Learning - STEMLab was analysed. STEMLab in its work has combined LEGO Education programs, Microbit, Arduino, Drones, 3D printing, and STEM activities from the brochure of the James Dyson Foundation. In this study, the authors investigated the perception of parents (N = 41) about the impact that extracurricular activities of STEM education have had on their primary school children, aged 6-14 years. Using the survey data, the authors together with the staff of the educational center, qualitatively and quantitatively analysed three important factors: management and communication with parents, STEM programs, and the impact of STEM education on children's success in formal education in public schools of the country. The results obtained show that the strategy of communication with parents, promotion of STEM, and protection of children's exposure to social networks is a powerful element in the work of STEMLab. In the questions about the program content and eventual innovations, it is seen that there is a gap of knowledge among parents about STEM programs, while a very high percentage of parents agree on the high impact of STEMLab on their children's success in the school learning process. Based on the results obtained, STEMLab seems as a very suitable and necessary model for the education of new generations in the Albanian-speaking region.

Keywords: STEM; parents; management; primary school

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Theoretical and Practical Inquiry of the Practice of Philosophy for Children (P4C) structured around Questioning of Moral Education"

Sümeyye Sel Odabaş[1]

Abstract

Philosophy represents the opportunity to wonder and opportunity to question the ideas, knowledge and values affirmed in the state of things, and our relationship to those affirmations. And also, philosophy opens the spaces of education so that its subjects can ask and wonder about the world they inhabit in such a way that, through the experience of philosophy, these subjects can no longer think in the same way before philosophizing. Philosophizing does not aim at imposing a new point of view as of childhood, instead intends to stimulate students to think on an argument through their own reasoning and helps them redesign an opinion in cooperation. This paper will focus on two intertwined sets of topics for approaching better to moral education: theoretical and practical inquiry

1. Theoretical inquiry includes argumentation, conceptualisation and questioning. In a practice of philosophy for children workshop, arguments are produced, criticised and analysed. What matters is to enhance our capacities of listening and understanding and to become eager to learn and research through using our minds. In this respect, practice of philosophy adopts the principle of pursuing the truth rather than being right by questioning and creating new concepts.
2. Practical Inquiry includes philosophizing with philosophical text of Thierry Dedieu's "Yakouba" comprising as a part of philosophizing tool for a moral dilemma and rethinking of virtue of courage. Also, a pedagogical sheet prepared in conformity with the methods of philosophizing which are conceptualization, questioning and argumentation is considered as a part of practical inquiry of moral education.

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A Sample Lesson Practice in Different Sociological Environments and Comparison of the Results

İnci Duygu Baytun[1], Ahmet Şahin[2]

Abstract

Thanks to STEM teaching, students use their knowledge and skills related to daily life in solving problems by combining them with technology, engineering, design, and mathematics. Therefore, in recent years, STEM applications have a special importance to support teaching. As a requirement of the changing age, robotic coding skills have also been included in STEM teaching. Robotic coding skills have enriched STEM studies by supporting the product or process. This work; It was applied to the students in Yüreğir district of Adana province. Students are in the same district but in different socio-economic conditions. It was applied in academically homogeneous 6th-grade student groups. The 4th unit of the Science course 6th grade curriculum is the subject of "Matter and Heat". This unit covers the importance of renewable energy sources and examples of these sources. A STEM activity enriched with the use of Arduinoo was organized on the subject. For this activity, 4 groups were formed each consisting of 6th-grade students studying at Kazim Karabekir Secondary School and Koza Secondary School in different education regions of Yüreğir. There are 3 people in each group. Groups were randomly selected and formed of students who were similar in terms of academic levels. A pre-test was applied to the groups about renewable energy sources. A 30-minute presentation was made and the materials to be used in the study were introduced. The working principle of robotic coding, which will be used in the measurement of the product to be produced, is explained. Coding was provided by the students. An example scenario was given to student groups. According to this scenario, they were asked to build a wind turbine that can use wind energy effectively. It has been stated that the number of revolutions per minute of the wind turbine is proportional to the electrical energy production. The platform where the product to be produced at the end of the event will be tested has been introduced. In order to ensure equal conditions, the height of the platform is adjusted to the hair dryer at a height of 20 centimeters. The blow dryer is used to create wind. The wind turbines created

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were fixed at a distance of 50 centimeters from the hair dryer and tested. A paper is attached to the back of the created wind turbines. Thus, the number of rotations per minute of the wind turbine will be calculated by the robotic sensor and the data will be transferred to the computer. Recyclable material options were presented to the groups and they were asked to realize their designs using up to 5 types of materials they would choose. They were given 5 minutes to make the draft drawings in order to determine the materials suitable for their designs. The products that emerged at the end of the event were tested on the specified platform. The post-test, which consisted of the same questions as the pre-test, was administered to the students again. The difference between the pretest and the pretest has been revealed. As a result, a sample application made with STEM activity in different socio-economic regions in the same district was compared in terms of its results.

Keywords: STEM: Renewable Energy; Energy; Robotics; Coding

Examining Preservice Biology Teachers' Verbal Question-Answer Process during their Teaching Practicum

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Abstract

The importance of the question-answer process as an effective teaching strategy and a challenging aspect of the profession makes it a crucial skill for preservice teachers to develop during their teacher training. This study aims to examine the characteristics of the verbal question-answer process of senior preservice biology teachers during their teaching practicum. Four preservice biology teachers were the participants in this qualitative study. All participants were enrolled in a compulsory five-credit field-based practicum course and were assigned to a high school and a biology teacher for the experience during the fall and spring semesters. For the present study, the participants were assigned to two different classes (9th and 10th grade) and taught in pairs for two class hours. Data collection tools were the Instrument of Question-Answer Process (IQAP), audio recordings of their planned lessons, and lesson plans. Findings collected from the participants were analysed qualitatively using the Initiation-Response-Feedback (IRF) framework and five dimensions of the verbal question-answer process: the source of the questions, the taxonomy of the questions, the respondents of the questions, teacher feedback, and the authority of the questions. The study's findings indicated that the participants thought both teachers and students were the sources of the questions. Regarding this dimension, the preservice teachers expressed those students who are curious, interested, and open to learning should ask more questions. In addition, teachers should ask questions to attract attention, encourage students to think and participate in the lesson and encourage shy students. However, in-class observations showed that the participants asked most of the questions during practicum. In terms of the taxonomy of the questions, they expressed that they would try to ask questions that could attract students' attention and help them connect the topic to their daily lives. However, in-class observation findings showed that the preservice biology teachers asked lower-order questions in remembering and understanding levels. Regarding the third dimension, the participants stated that they initially preferred volunteer students to answer the questions and then try to seek answers from non-volunteer students. Teacher feedback dimension findings showed that the participants generally preferred redirection and probes, and only

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two student teachers mentioned immediately affirming or denying only to express appreciation. The teacher feedback dimension was also not consistent with in-class observations since all the participants affirmed and denied immediately when they gained a response from students. In terms of the authority of the answers, only one of the participants stated teacher and students should determine the answers together. In contrast, the rest of the participants said that finally, the teacher decides the answer or the best solution. Although this study was carried out with a small number of student teachers, it contributes to the current understanding of the question-answer process by shedding light on how the characteristics of the student teachers are in theory and practice.

Keywords: Biology education; question-answer process; student teachers; teacher education; teaching practicum

Development of Secondary Skills through A TPD Scheme on Climate Change Education

Smaragda Lymperopoulou[1], Silvia Alcaraz[2], Albena Antonova[3], Mario Barajas[4], Gultekin Cakmakci[5], Sonia Hetzner[6]

Abstract

Education is probably one of the most crucial factors against the global crisis of climate change. Educational stakeholders and especially teachers can facilitate this mindset change, increasing students' knowledge and environmental awareness as well as encouraging them to adopt a more sustainable lifestyle. Therefore, it is crucial for students to understand how climate change can affect their lives and why it is essential to hold an active citizen role in society. For example, students can understand how taking part in programs dedicated to environmental awareness, development of good practices on climate change, etc., they can adopt an environmentally-friendly behaviour and a more sustainable way of thinking before acting.

During COVID-19 and the long period of self-isolation in many countries around the globe, the need for the digital transformation of education was more than urgent. All the EU countries as well as the European Commission promote teachers training programmes in order to develop digital literacy skills in both creating digital teaching material and improving their teaching in online educational environments. The Erasmus+ project entitled "Towards a new model of Teachers' Professional Competence Development on Climate Change" (Acronym: ClimaTePD), comes to bridge climate

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change education and to help in-service secondary teachers in developing digital skills through Teachers Professional Development schemes (TPD) as means to improve their digital teaching methods and integrate ICTs in open and distance learning education. Additionally, it comes to update and improve teachers' digital competencies by introducing new examples and new open-access digital educational materials, gamification methods and tools within the teachers' digital competencies framework and the educational communities.

Investigating climate change education, teachers' digital literacy, and the TPD schemes in Greece, Turkey, Spain, Bulgaria, Germany (consortium countries) and beyond, we could underline that digital skills can be transformed into a very successful tool which brings together different target groups and especially the school communities in order to follow a common strategy towards essential social learning on climate change. A multi-dimensional learning approach of climate change education, which includes digital tools, game-based learning, educational scenarios and competencies teaching "toolkits" that will be used by the teachers as supporting teaching material in f2f, digital and blended learning environments, will be more than beneficial for the students in all countries.

Herein, we focus on the state of affairs regarding climate change education in Greece, Turkey, Spain, Bulgaria and Germany, the embedment of the climate change dimension in secondary school curricula and the inclusion of climate change and digital teaching skills in TPD schemes across the five countries of the consortium.

Keywords: ClimaTePD Project; climate change education; digital skills; IBL; gamification; TPD schemes

About the Experience of Organizing STEM Education in M. Auezov SKU

Dildabaeva M.S., Shomanbayeva M.T., Zhaydakbayeva L.K., Kurakbay O [1]

Abstract

One of the recent innovations in pedagogy is the growing popularity of the phenomenon of STEM education. A number of countries are already introducing STEM ideas into educational institutions, achieving positive results in increasing the importance of engineering education, as well as the quality of training students in technical disciplines.

Robotics, construction, programming, modeling, 3D design and much more - all this is now of interest to modern schoolchildren around the world. More complex skills and competencies are needed to realize these interests. Thanks to the rapid development of technology, new specialties are emerging, the demand for STEM specialists, the specialties of tomorrow, is massively growing. to a world developed from a point of view. Future professionals need comprehensive training and knowledge obtained from various educational areas of science, engineering, technology and mathematics. STEM (science, technology, engineering and mathematics), an integrated approach to learning in key academic areas such as science, mathematics, technology and engineering, is in great demand. After all, within its framework, academic scientific and technical concepts can be explored and used in the context of real life.

The system of views on the basic principles, goals, objectives and main directions for the development of teaching mathematics, the STEM approach in education are indicated in the "Strategic Development Plan of the Republic of Kazakhstan until 2025". The curricula will include STEM elements aimed at the development of new technologies, scientific innovations, mathematical modeling, programming, robotics and initial technological training. To provide the country with qualified teaching staff, pedagogical departments and faculties at universities will be developed. The quality of teaching mathematics and natural sciences at all levels of education will be improved.

The STEM approach has not bypassed our South Kazakhstan University (SKU) named after. M. Auezov. In January 2019, SKSU named after M. Auezov became a member of the consortium of universities of the European project "Integrated Approach to STEM Teacher Training". The goal of the project is to improve the quality of STEM teacher training in accordance with the provisions of the Bologna process and the requirements of a modern knowledge economy. As part of the implementation of this project,

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master's programs for the training of STEM teachers have been developed. South Kazakhstan University named after M. Auezov, within the framework of the Erasmus + project, held the International Summer Online School "Modern Trends in STEM Education" for students of educational programs in the field of pedagogical and natural sciences, engineering, technology and future STEM teachers from July 27 to July 31, 2020. A STEM resource and training center has been created.

At the departments of "Informatics" and "Physics" specialties in STEM technologies are currently open in the magistracy. The STEM approach is implemented in the educational program 6B01532 - "Computer Science and Robotics" for undergraduate studies. The discipline "STEM technologies in education", "Digital literacy", "Digital technologies in education", "Fundamentals of robotics and IT technologies" has been introduced into the curricula of pedagogical specialties of the Department of Informatics. The Department of Informatics has repeatedly held online festivals on STEM education and robotics, which was attended by students from urban and rural schools, colleges and universities.

A new trend in STEM has become educational robotics, which allows you to develop programming and design skills, being an integrator of all four components of STEM.

Educational robotics is a modern technology for teaching the younger generation, which in a creative form will allow you to study sciences such as physics, mathematics, drawing, technology, cybernetics, and many other sciences. Robotics is today the first step in a new, modern education, which is aimed not at cramming educational material, but at turning education into an exciting, lively process that will allow you to more deeply study all types of modern sciences.

The Suleyman Demirel University hosted the Republican Robotics Championship among schoolchildren - FIRST Kazakhstan Robotics Championship. More than 800 schoolchildren from different parts of the country took part in this program. They competed for the main prize - a trip to the United States. Given the age characteristics, students in grades 1-11 turned on their robots and competed with each other.

Undergraduates of the Department of Informatics take an active part in the training of schoolchildren of the city in the field of robotics and programming. . They teach students at the Robo Park School of Robotics and Programming and represented 4 teams from the city of Shymkent at the Republican Robotics Championship FIRST Kazakhstan Robotics Championship. Two teams for the First Explorer category and two for the First Challenge. Senior teams were prepared by undergraduates Kurakbay Olzhas and Nuridin Akniet, and junior teams - Zhaksylyk Nesibeli and Ahmet Akbota.

The junior team showed the most successful result and received a license to participate in the final stage of the competition in Moscow.

The senior team aged 10 to 16 got into the TOP 10 best teams of the championship, taking ninth place out of a total of 75 participants.

Our country is moving in the same direction as the developed countries. STEM education is the bridge between study and career. His concept prepares children for the technologically advanced world. The professionals of the future require comprehensive training and knowledge from a wide range of educational fields in science, engineering, technology and mathematics.

Teachers should encourage students to research, teach not to be afraid to make mistakes and draw conclusions. Much attention in the classroom should be paid to the development of communication skills and project activities. These qualities will be especially important for working in the organizations of the future.

Keywords: STEM Guidelines for Knowledge Implementation. - Astana: National Academy of Education. Y. Altynsarina, 2017. - 160 p.

Implementation of STEM in Preschool Education Using Experiments

Ebiha Demir[1]

Abstract

The aim of implementation of STEM in preschool education is to create positive and pragmatic examples for both teachers and teacher candidates. In first the project, to introduce the terms such as ''deforestation'', ''erosion'' and '' environmental impact'', STEM principles have been implemented and an experiment has been used to better visualize the effects of erosion to 5 year-olds. Before the experiment was carried out 5 year-olds were shown animations about erosion and a discussion was carried out about the possible effects. To improve their critical thinking and analysing skills, they were individually given a chance to make guesses about the experiment before and during the implementation. After the experiment was conducted they were encouraged to compare their guesses to the results. Pictures and a video were taken during the experiment to later analyse the footage to improve the experiment for future implementations. The place for the experiment and the materials were also prepared with the help of the children to increase the feeling of involvement. In the second project, capillary action was introduced and observed with the help of two plastic cups filled half with water, a piece of napkin and felt-tipped coloured pencils. Two steel trays roughly the same size, same amount of dirt with and without plant roots and two bottles of water have been used during the experiment. Children were instructed to paint each side of the napkin with their coloured pencils then to dip each side into the plastic cups. It was explained after they dipped the sides of the napkin that the reason the colours were connected is because of capillary action which is water moving through the veins like structure of napkins. Both projects were conducted by the researcher herself and with 15 students who are 5 year-olds in a public kindergarten in Istanbul.

Keywords: STEM, experiments, critical thinking, analysing, preschool education

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Application and Development of STEAM Project in Azerbaijan

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Abstract

The main goal of the STEAM (Science, Technology, Engineering, Art and Math) project is to develop students' 4C skills - critical, creative thinking, collaboration and communication skills.

For 6th, 7th, 8th and 9th grades students of STEAM schools, knowledge and skills about "3D printing", "Micro:bit Coding", "Biotechnology", "Nanotechnology", "Robotics", "CNC laser cutters and engravers", "Unmanned aerial vehicles (training drones)" are formed on the basis of curriculum program in the process of education. There are also engineering (genetical, aerospace, electrical, ecological, chemistry, construction, industrial)entrepreneurshiip, cooperation skills being encouraged.

The activities carried out by the project are regularly communicated to the followers via the official Facebook, YouTube, Instagram, Twitter social networks of the STEAM Azerbaijan project through videos and photos.

New Modules:

1. Neuroscience

2. Nanotechnologies

3. High Tech and Low Tech skills

4. Enterpreneurship

"STEAM (Science, Technology, Engineering, Art and Math)" project was implemented by the Ministry of Education and it is in 3rd year of its application. The development of individual abilities, the establishment of creative procedural learning possibilities, and subject expansion are not the sole concerns of the twenty first century. Additionally, it is merging the aforementioned elements into a single learning model with applications in the actual world and strengthening the usage of contemporary ICT tools to apply various programming languages.

In the academic year of 2021-2022, the project covers 302 secondary schools in 50 cities and districts

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across the country, as well as more than 100,000 students from 15 STEAM Centers. The teacher's manual and assessment methodical manual reflecting the topics corresponding to the grade levels of the STEAM teaching process were prepared based on the above-mentioned modules and made available to the educators. Modules based on modern bio and nanotechnology, robotics and CNC laser cutters and engravers were expanded and got more space in our curriculums.

Along with the educational process, various festivals, such as STEAM Azerbaijan Festival (SAF), competitions (Makerthon, Hackathon), and contests are held within the project in order to increase the interest of students in STEAM, to exclude talented students. More than 450 teams and 900 students competed across 10 categories at first SAF that was held in 2021. Also, STEAM solely organized a brand new "Baku Skills" category based on 3D printing and modeling skills within "Teknofest Azerbaijan 2022". More than 225 teams and 1300 participants took part in "Baku Skills".

In December 2022, the project plans the STEAM Azerbaijan Festival to be held at the international level. The festival will be attended by both domestic and foreign students in the categories of Hackathon IoT, VEX IQ Challenge VIQC, VEX Robotics Competition, Lego Robotics High school, Lego Robotics Middle school, Lego Robotics Middle school, 3D Cad, Drone Competition.

In order to ensure the accessibility of the project to every citizen, along with its implementation in secondary schools, 15 STEAM Centers were established and put into operation across the country, 2 Centers were opened to increase the total number of STEAM Centers to 15. Both secondary schools and STEAM Centers are equipped with the necessary innovative technologies and equipment.

Along with the STEAM Centers, international cooperation is being carried out and various work is being done to establish a STEAM Innovation Center by STEAM Azerbaijan.

The main purpose of establishing the STEAM Innovation Center is to further develop the basic knowledge of modern technologies, to form an idea of the professions associated with the studied technologies, their place in the labor market, and the current state of demand for these areas.

It's also desired to master the different methods of scientific research and project activities, to improve the ability to connect the knowledge gained in different disciplines in solving problems.

Scientific research in the Museum of Science, practical experience, organization of classes to develop special knowledge and skills, teaching VR education based on virtual reality, trainings on the development and implementation of startup projects, study and application of innovative technologies, joint activities of qualified people of different ages implementation of activities such as organization.

A Unified Electronic System (VES) has been improved – now educators are able to get teaching materials, resources, and all the needed information about education the process from this platform.

Keywords: STEAM methodology; effective pedagogical strategies; historical experience; pedagogical science; new modules.

Development and Use of Smart RGB Lamp in STEM Education

Maksim Velichko[1], Elena Esina[2], Valentina Kormakova[3]

Abstract

The purpose of STEM education is to develop highly organized thinking among students and students and to teach the effective application of the acquired knowledge in the field of natural and engineering sciences, technology, mathematics and art, programming, and ICT through project-based learning. Even such related disciplines as history and geography are rarely interconnected in the educational process, and a modern schoolchild or student will not always be able to show the places of key historical events on the world map: there is practically no connection between various subjects in his internal educational system. The absence of such logical connections between school subjects affects the solution of life tasks. The International Program for the Assessment of educational achievements of students (PISA) shows that Russian schoolchildren hardly cope with non-standard life tasks where they need to apply their theoretical knowledge.

The article is devoted to the development of a new hardware and software complex of the smart RGB lamp. The presented device is the result of the implementation of a scientific and educational project in the field of STEM disciplines. It integrates knowledge in the fields of electronics, optics, robotics, signal processing, object-oriented and web programming, web design, engineering, and mathematics. An initiative group of teachers, undergraduates, students, and schoolchildren, each of whom performed their own functions, was involved in the implementation of the project. The synergetic effect was achieved, among other things, through the use of STEM tutoring principles. The process of designing and creating the lamp structure, the process of developing software for the microcontroller, for the client and server parts of the device was outlined. A mobile cross-platform web application for device management is described in detail. The practical application of this lamp was demonstrated. The pedagogical effect of the implementation and application of the project experience is shown. It is proved that such projects are part of a new information educational environment.

Keywords: STEM education, RGB-led, JavaScript, Arduino, microcontroller, robotics, digitalization, WiFi

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First Steps to STEM

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Abstract

The aim of this STEM study is to develop the skills of curiosity, research, inquiry, comparison, critical and analytical thinking in preschool children, as well as creating solutions to problems and to enable them to acquire 21st century skills especially digital skills. During the project period, it was aimed to go beyond the rote-based and passive learning system and to transform knowledge into practice, product and innovative inventions so experiential, doing-living, active, and versatile teaching activities were carried out. In this study, a STEM field was studied every month. Experiments, observations, and integrated activities related to that field were applied. Many experiments and activities have been carried out in the fields of science and technology, such as water, air, matter, electricity, density and environmental pollution. In addition, 3D designs with virtual reality applications and creating puzzles and avatars with various web 2.0 tools, dubbing of famous scientists fulfilled. In the fields of engineering and mathematics, the subjects of balance, construction, clock, mathematical operations, coding were covered and reinforced by diversifying them with integrated activities. The students conducted research on famous scientists and prepared presentations by vocalizing the people they researched using the web 2.0 tool. In addition, they have made remarkable progress in communication and cooperation, and they have collaborated with their project partners. The joint STEM magazine and a virtual exhibition were created. In addition, the density of liquids experiment was carried out with the participation of partner schools. Inspired by the storytellers who traveled from village to village in Anatolia in ancient times, the robot, which was created jointly, visited all partner country schools and told tales. The project was promoted through various web and news sites, social media channels, blogs and local newspapers. In the 2021-2022 academic year, the study was carried out with the participation of 110 students from 3 countries, 6 schools. According to the evaluation survey results, all the participants were satisfied with participating in this study, they enjoyed and wanted to take part in a STEM project again. At the end of the project, 97.4% of pupils gained awareness in STEM. According to parents' survey results, all of the parents were satisfied with being involved in the project. While 94.6% of the parents thought that the subject was beneficial for their children initially, this rate is 100% at the end. While 24.3% of

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the parents were doing experiments initially with their children at home, this rate has risen to a very different level, such as 97.4% at the end. 54.1%of the parents were designing their own toys with their children this rate increased to 82.1% at the end. Generally, the pupils and parents gained awareness about STEM issues, and at the same time, the parents received a constructive orientation training in terms of being a guide for their children. It has been seen how simple, fun and life-related these areas are, which students generally think they are difficult. This was the foundations for their next school years.

Keywords: STEAM Project; creative thinking; cooperation; coding.

The Role of Computerized Laboratory Exercises in Development of Key Competences

Andrej Šorgo[1], Vida Lang[2]

Abstract

The European Union has recommended that schools include eight key competences for lifelong learning in their curricula. The problem with this recommendation for a teacher of a regular subject (e.g., science) is that competency-based didactics is still at a very early stage and lacks models that can be directly applied to actual teaching. While it is assumed that all competences are equally important, it is very unlikely that every teacher contributes equally to the development of all eight competencies when teaching their subject. Therefore, interdisciplinary and transdisciplinary collaboration among multiple teachers is a plausible solution. This strategy is most often used in the context of project days or specially designed events that constitute only a small part of the curriculum. While such an approach can lead to some plausible outcomes, it does not readily translate to prevailing traditional schools. Due to organizational problems, it is almost impossible to organize such a strategy in traditional schools with fixed daily schedules.

Consequently, activities must be developed that are embedded in the science curriculum and regular classes that follow the traditional schedule and enable the teacher to teach the multicompetency approach. The problem is that teachers of a particular science subject may have extensive pedagogical content knowledge in the subject they teach, but not in the core disciplines needed to develop other competences. For science teachers, the core competences are "Mathematical competence and competence in science, technology and engineering" and "Digital competence" while they need to support the development of the other competences. Therefore, helping students develop creativity, problem solving, and critical thinking as transversal and cross-cutting skills not only brings digital literacy and science and scientific literacy (competences) to a higher level, but also the other competences as well. The best part is that such strategies can be combined in the regular classroom by a teacher.

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With the ubiquitous use of computers, and more recently with the advent of smart portable devices (smartphones and tablets), it has become possible to incorporate many experiments into science lessons that were unthinkable in traditional school labs. As shown in previous analyses of hands-on work, it is possible to teach students how to collect, organize, analyse, and report data and results while developing problem-solving skills and critical thinking through the use of computer-based labs. While experiments with computers and data loggers are confined to the classroom, the use of cameras and sensors embedded in smartphones allows students to experiment on their own and apply what they learn in new contexts.

Keywords: Key competences; computerized laboratory exercises; science education; smartphones

A Workshop for Meaningful School Community Projects

Gokhan Kaya[1], Metin Sardag[2], Semra Akgonullu[3]

Abstract

This workshop will be carried out as part of the MOST project, which is a Horizon 2020 project. The MOST project intends to open up school education by initiating school-community-projects (SCPs) across Europe. Within a school-community-project, schools and community members (families, science education providers, citizens, businesses, etc.) work together to find regionally implementable and scientific approaches to sustainable issues.

The main aim of school community projects is to develop locally applicable solution approaches by working together with students and citizens on environmental issues such as waste and energy management. Within the scope of these projects, students find a problem and investigate it based on their own reality under the leadership of the teacher. During this research, they must interact with experts, stakeholders, or members of the public related to that problem. During these interactions, they reveal the quality of looking at the problem from different perspectives or how researchable their thoughts are in producing solutions to the issue. Then, they propose solutions to the problem using a data-based structure. These solution proposals are shared with the relevant units of the society, and a change is tried to be created.

During this workshop, firstly, after this project process is summarized, the participants will work with experts on a sample scenario to collect data with various data collection sensors and present a solution or an explanation to better understand the problem based on the data they have obtained. In summary, the processes experienced by the students in these projects will be tried to be experienced by the participants. At the end of the workshop, the points to be considered in SCP projects will be discussed and suggestions will be made.

Keywords: School-community-project, STEM, inquiry-based learning, data collection

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Micro:bit; cheap and simple hardware for coding

Armin Ruch[1]

Abstract

Digitalization is present in almost every aspect of our private and professional life (Gervé, 2019; Timm, 2016). The industry, the major driver of this development in Germany (Spöttl & Windelband, 2017), has defined competences to be developed in job qualification. These should include the comprehension of systems, a focus on processes, debugging and localization of malfunctions, diagnosis, and problem-solving ability (Bundesinstitut für Berufsbildung, 2017). Problem solving in this context is defined as the competence to think about and find solutions for situations that are new for the individual. This means that the situation is not familiar from previous learning situations so that no routines of reaction have been established and no standard solution can be used (Pauen et al., 2007; Perleth, 2008). Skills and competences are processed and stored in different areas of the brain (Möller et al., 2002). In order to prepare today's children for a digitalized work environment and private life, digital skills must be part of current curricula. However, the acquisition of aforementioned skill is a long process that should be begun as early as possible. Still, private initiatives are still needed to fill the gap in education ("Passionate Turkish engineer promotes coding for children," 22.08.2022). While the findings about digitalization mentioned here are based on experience and literature from Germany, the same can be assumed for Türkiye. Research in education since the 1970s has shown that children already have knowledge about scientific processes and terminology even though they have never been formally been exposed to it in a formal learning setting, such as school (Löffler, 1991; Möller et al., 2014; Schönknecht & Maier, 2012; Schwelle et al., 2013). A crucial factor for performance in test situations is domain-specific-prior-knowledge (Jonen et al., 2003). It suggests that it is important to start age-appropriate education as early as possible. Recent unpublished research suggests that the basis for digital competence can be lain as early as first grade (Ruch, 2022). However, teaching children how to code is currently very challenging for educators. Based on several years of experience as a coding instructor for teachers, among the most common problems for educators are the complexity of the code, the complexity of the technology, and the price of the hardware. Most educators are not aware of the fact that in England a solution has been developed to solve exactly those problems. The BBC in England

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developed a tool specifically for the use in education children in Primary School and upwards, called the Micro:bit. It combines very, very easy to use plug-and-play technology, a browser programming surface, an intuitive programming language, and an affordable price. Today, the Micro:bit is managed by the non-profit organization "The Micro:bit Educational Foundation". The efficiency of the system are proven in several international studies (Micro: bit Educational Foundation, 2022). Due to the fact that the Micro:bit can be used as early as children can read and write, personal experience has shown that educators have doubts about the complexity of the Micro:bit and weather or not it can be also used for complex problems. One might think that the Micro:bit is simple. The opposite is the case, as the Micro:bit is upwards usable up to University classes and very complex projects, as the Micro:bit is already equipped with variety of sensors and actors. As the focus lies on the programming, all sensors and actors are already built into the Micro:bit and can be used immediately and without any knowledge about electronics, as it is necessary for the use of other systems, such as the Arduino. Even though the Micro:bit is already equipped with sensors for temperature, light, acceleration, electromagnetic fields, bluetooth, radio, buttons, and a USB-interface, the Micro:bit can be bought in Türkiye for 375 TL + KDV at the official distributor "Samm Market". What makes the Micro:bit good for schools is the fact that an online platform has been established for the purpose of worldwide education (www.makecode.microbit.org). This becomes clear, as the language can be set, amongst others, to Turkish. Therefore, children and teachers do not need skills in English in order to code. The block-based programming is very intuitive and offers a simulation of the hardware that can be used to test programs even without the hardware. This, again, is a great advantage for schools that might not be able to equip every student with one system. Programs can be saved and reopened on other computers, thus making homework possible if a computer with internet access can be used. A real life problem that is known to most children are lights that automatically switch on, when it a certain degree of darkness is reached and turn themselves off, when a certain degree of light is reached. This connection can be easily explained by children, though not in terms of computer programming. With the Micro:bit, children can build on their previous knowledge, as they find blocks for what they already can describe in their own words. For later, the code can be switched between blocks and the more complex language JavaScript with one click, thus opening the system to higher age groups and more difficult challenges. Overall, this abstract is based on the experience of the author as an instructor for coding in Germany. Due to the relevance of the topic and its intrinsic urgency, as well as the potential of the Micro:bit system, more research about the effectiveness of the Micro:bit in the Turkish educational system is suggested. Promising is a first publication about the use of the Micro:bit by Orhan Celep (Celep, 2020) that can be used as a reference and guide for first steps with the system.

Keywords: STEAM Project; coding; hardware; digitalization; innovative technologies

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A Stem Learning Scenario: Growing Plants In The Hydroponic System With 10th Grade Students

Özlem Saygın[1], Ayşegül Gençer[2], Durdu Aslı Kaplan Yaşkaya[3], Şerife Demirel[4]

Abstract

Hydroponic agriculture is one of the plant-growing methods of the 21st century. It has become widespread today, the plant factories started to be established due to reasons such as the decrease in water resources, the rapid increase in urbanization, population growth, food shortages, and soil pollution. The STEM projects develop students' skills like problem-solving, critical thinking, productivity, collaboration, communication, information and technology literacy, initiative, and social skills. In this project, our activities are associated with the STEM careers such as environmental engineering, biochemistry, biotechnology, management of biological resources, agricultural engineering, and computer engineering. The aim of our project was to learn about growing plants in the hydroponic system. Students gained knowledge and experience in how to grow plants in soilless conditions inside the buildings.

The activities of the Hydroponic System were implemented in 10th grade (age 16) in Antalya Erünal Sosyal Bilimler Lisesi, Turkey. STEM activities were held in a total of 10 lesson hours, including physics, chemistry, biology, mathematics, and information technologies lessons. Firstly, we asked students some questions about real-world problems and got their solution suggestions. Then, students were divided into groups, they decided to do deep water culture as a practice of the hydroponic system. They researched necessary conditions for plant growth, the quality of water, essential minerals, and the importance of the wavelength of light. The groups did internet research and watched videos both in English and Turkish about the hydroponic system setup they have chosen. They made the list of the necessary materials to install the hydroponic system and shared the tasks.

In the next week, students set up their hydroponic system. Firstly, they cut styrofoam suitable for the storage container. They drilled round holes for the perforated pots on the styrofoam. For each liter of

1, 3, 4 Antalya Erünal Sosyal Bilimler Lisesi

2 Antalya Manavgat Fethi Yılmaz Sezer Mesleki ve Teknik Anadolu Lisesi

water placed in the container, 2 ml of A and B nutrients were added, and the air motor and air stone were placed in the water. Then, we adjusted the EC=0.8 mS/cm and pH=6.0, these values are for lettuce. In the chemistry lesson, students learned which minerals plants need and how to calculate the ratios of chemicals in a mixture. In the physic lesson, students investigated the effect of the wavelength of light on plant growth. They used LED lighting with an intense red light so that the plants can grow faster in a low light environment. Then, they programmed its timing to be ON for 16 hours (lighting) and to be OFF for 8 hours (dark) via the Arduino. Students measured and recorded the EC, pH, and temperature of the water every day. We made the necessary EC and pH adjustments daily. In the mathematics lesson, students drew graphics of daily pH increases and the temperature of the water. After 5 weeks, our lettuces grew enough, and we harvested them.

As an evaluation, we used the self-assessment and teacher assessment forms. Students enjoyed trying something new and they realized that growing plants takes effort.

Keywords: STEM; learning scenario; hydroponic system; soilless agriculture; high school

STEM Contribution to the Development of Technical Vision Hardware and Software Complex for Concentration Tables

Maksim Velichk [1], Vladimir Esin[2], Natalya Zinchenko[3]

Abstract

The paper presents the experience of using STEM technologies in the development of a prototype of a full-fledged high-tech device. It is the technical vision system for the concentration tables. It is shown that new technologies applied to the design of concentration tables will significantly help companies, specializing in extraction and handling of common minerals in deep processing of construction sands in order to obtain more expensive products. Technical vision hardware and software complex is considered as one of automation systems, that can greatly improve productivity of concentration tables, provide energy, human and essential mineral resource-saving (e.g. of such minerals as titanium-zirconium raw material). Described is the mechanism of different fractions dividing on the concentration table. Shown is the process of dividing line recognition by technical vision system. Depicted is the system structure and the used elements. Pictured is the software general operation including camera image analysis before making decisions and hardware control.

It is shown that an integrated interdisciplinary approach to education in the field of mathematics and natural sciences makes it possible to develop the creative potential of students and use it when creating devices in demand on the market, especially in a situation when it is necessary to establish new educational, scientific, technical and industrial ties in a rapidly changing world.

Keywords: Technical vision; computer vision; image processing; concentration table; tailings processing; STEM

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Case Studies of Innovative Learning Pathways to STEM

Panagiota Argyri[1]

Abstract

Teacher participation in European digital communities for the use of digital resources, tools, innovative teaching and learning practices is an important form of professional development. Scientix is the number one community for science education in Europe and it aims to promote and support a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other educational stakeholders to inspire students to pursue careers in the field of Science, Technology, Engineering and Mathematics (STEM). In this paper, analyzed case studies of creation and dissemination of educational learning scenarios, through the participation to the projects of the Scientix repository. The case studies include interdisciplinary teaching approaches for STEM lessons and based on the connection of the cognitive areas of the science courses and functions as a bridge for the connection of their knowledge (school) with the study of real problems (society). A key feature is the assumption of multiple roles by students with the aim of multifaceted development of their personality and skills required by modern social reality. The context of education for sustainable development is characterized by holistic pedagogy, which on the one hand incorporates critical issues, but also aims to cultivate the basic skills of cooperation, communication and critical thinking, the adoption of values and approaches to addressing global challenges. The basic characteristic of the holistic pedagogy is that increase students 'interest in science, its role, how it affects daily life, and, second, stimulate teachers' motivation in innovative teaching methods to enrich and enhance curriculum by applying scientific knowledge to real problems that will prepare students for future roles and decision-making as members of the social community. It is critical for students to understand themselves and their relationships with others, as well as to realize their individual and collective impact on the world around them. These teaching methodologies based on the problems of the 21st century and ask students find solutions locally and globally and as result is that equip them with relevant skills, knowledge, behaviours and values and empower them to learn how to play an active role in their local community, in shaping a more equitable and sustainable world at large, in balancing the demands of the environment, society and the economy.

Keywords: STEM; Scientix repository; educational learning scenarios; skills.

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What are STEM subjects?

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Abstract

STEM stands for science, technology, engineering and mathematics and refers to any subject that falls within these four disciplines.

As mentioned, STEM stands for science, technology, engineering and mathematics, but a wider range of academic subjects falls under this description. Here is a list of some other STEM courses you can study:

- Aerospace engineering
- Astronomy
- Biochemistry
- Biology
- Chemical engineering
- Chemistry
- Civil engineering
- Computer science
- Electrical engineering
- Mathematics
- Mechanical engineering
- Physics
- Psychology
- Statistics

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The full list is more comprehensive, but it gives you an idea of the range of subjects included in STEM.

In terms of career paths, some of these topics will offer a fairly straightforward progression into certain careers. For example, aerospace engineering could lead to a graduate job working for one of the world's largest aircraft designers, such as Rolls Royce.

Not every STEM-related graduate job is this open. For example, a STEM degree can lead to a career working on special effects in Hollywood, helping to design new sportswear, or revolutionizing the agricultural industry. This is in addition to roles in areas such as finance and accounting, construction, telecommunications, and the energy sector.

Keywords: STEM; STEM courses; STEM subjects

Learning Mathematics with Programming and Robots

Paulo Jorge Nogueria Torcato[1]

Abstract

In the digital age, programming skills are an essential requirement. The introduction of programming in an interdisciplinary context contributes to the improvement of learning and the acquisition of 21st century skills by students. On the other hand, the reality of schools has undergone major changes in recent years with the proliferation and use of technologies. The new reality, of classrooms, leads to the emergence of new environments and new learning strategies. "The emerging environments may contribute to the conceptual renewal of education, favouring the integration of informal domains of social and cultural practices in formal learning, by bringing the construction of school knowledge closer to the spaces of professional production and application" (Dias & Osório, 2008). Educational robotics is increasingly seen as a learning strategy capable of promoting self-learning and involving teachers and students in scientific research activities. It values cooperative work, interdisciplinarity and problem-solving skills. It motivates students, stimulates creativity and critical thinking. The student looks for solutions to problems, builds and reinvents (Passerino & Possamai, 2005). Its use in the classroom will allow students to develop interdisciplinary activities in their area of interest by increasing their motivation for learning and skills development (Reswick, 1991, cited by Benitti, 2012). According to Zilli (2004, cited by Gaspar,2007) educational robotics provides students with the development of the following skills: - Logical reasoning; - Research work; - Investigation and understanding; - Critical capacity; - Use of creativity; - Representation and communication; - Interpersonal relationships; - Manual skills; - Application of formulated theories to concrete activities; - Learning from mistakes. We present several activities using programming and robotics carried out in classes from 7th to 9th grade in a Portuguese school. Several themes were worked, namely: Construction of regular polygons, experimental determination of the radius of a wheel and direct proportionality. Afterwards, the students reflected on the results obtained and, in each class, a debate was held to explain and justify the results and draw conclusions. References: Dias, P. & Osório, A., (2008). Ambientes educativos emergentes, Braga: Universidade do Minho. Gaspar, L. (2007). The robots in informatics classes. Master's Thesis presented to the University of Madeira, Funchal Passerino, L. & Possamai, C. (2005). The process of cooperation and problem solving supported by educational robotics with adolescents, (pp. 1324-1333)

Keywords: Mathematics; Physics; Computational Thinking; Programming; Robotics

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Programming and Robot Simulators in Mathematics Teaching

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Abstract

Using visual languages, associated with robot simulators, activities are carried out within the framework of mathematics. Thus, contributing to the development of: - logical-deductive knowledge; - 21st century skills; At the same time, students consolidate the essential learning in the area of Mathematics. The objectives of the activities are - learn to establish connections between geometric relations and numerical relations, using Programming and Robotics; - to foster motivation, cooperation, persistence, critical sense, argumentation capacity, thought organization and participation Using Scratch and the simulators Open Roberta Lab and VEX VR, the aim is to carry out activities with a view to learning or consolidating knowledge and skills

Keywords: Programming; Mathematic; Computational Thinking; Simulators,Robotics

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Meaningful Open Schooling Connects Schools to Communities (MOST)

Metin Sardag[1], Gokhan Kaya[2], Gultekin Cakmakci[3]

Abstract

Societies need a deeper understanding of science and technology if they engage actively in the decision-making process as responsible citizens. To ensure the relevant and meaningful participation of all social actors, to increase participation in science studies and science-based careers, and to improve employability and competitiveness, cooperation between formal, non-formal, and informal education providers, business, and civil society should be developed. In line with these, open schooling includes the understanding that schools are places influencing community well-being in collaboration with other stakeholders, encouraging families to be real stakeholders in school life and activities.

The MOST project (Meaningful Open Schooling Connects Schools to Communities) is a project created by considering the mentioned issues. The MOST project is a Horizon 2020 project to be carried out between 2020 and 2023, with 23 stakeholders from 10 European countries as project partners [www.hstem.hacettepe.edu.tr/tr/most-36]. The project aims to create open schooling communities across Europe and establish a European open schooling network. In line with the aims, the partners introduce School Community Projects in their regions, foster girls to tap their science potential, encourage schools for institutional change, construct a website for the European open schooling network, and connect open schooling communities in both a region and across Europe [www.icse.eu/most/].

Within the project's scope, school community projects are carried out in the waste and energy management fields. Additionally, a five-stage roadmap, Invite, Co-Create, Act, Share, and Evaluate, has been created to practice the projects with secondary school students [www.icse.eu/most/].

Keywords: Open Schooling; School Community Project.

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How Ready are Teachers to Use Active Methods, Digital Tools and Gamification Techniques in Class – the ClimaTEPD approach

Albena Antonova[1], Kamelia Yotovska[1], Asya Asenova[1], Silvia Alcaraz-Dominguez[2], Mario Barajas[2], Katherina Kikis-Papadakis[3], Smaragda Limperopoulo[3], Yorgis Androulakis[3], Sonia Hetzner[4], Emel Loeffelholz[4], Gultekin Cakmakci [5], Orhan Curaoglu [6]

Abstract

Teaching about climate change in secondary school education is both complex and demanding for in-service teachers. On one side, climate change issues go beyond the subject-oriented curriculum, often addressing interdisciplinary dimensions in the field of STEM or social science. On the other side, the fast accumulating data and evidences about climate change gradually expand human understanding of the real-life processes, requiring both teachers and students to form positive attitudes for "learning to learn". Therefore, climate change education should prepare new generations to pro-actively study open-ended problems, employ digital technologies to investigate complicated cause-effect dependencies and explore appropriate solutions.

The paper aims to investigate the teachers' readiness and attitudes for using active methods and inquiry-based learning scenarios (IBL), game-based learning and digital tools in the field of climate change, based on empirical data. The study is part of the ClimaTEPD Erasum + project for in-service teachers' professional development for climate change education.

The paper starts with a short overview of the active-learning methodologies, using game-based learning and digital tools and exploring the 25 IBL scenarios, developed by the ClimaTEPD project consortium.

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Then, the survey methodology is outlined, followed by the analyses of the empirical results. The discussion part provides a summary of the teachers' attitudes, experiences and preferences for adapting climate change scenarios in partner countries. At the end are defined the practical considerations and next step for ClimaTEPD project implementation.

Acknowledgement: the present research is partially supported by project ClimaTEPD (2020-1-EL01-KA226-SCH-094834) - Towards a new model of Teachers' Professional Competence Development on Climate Change.

Keywords: Active learning methods; inquiry-based learning; gamification; digital technologies; climate change scenarios