БЖ4) показывает, что все приготовленные вяжущие соответствуют требованиям СОУ 45.2-00018112-036:2008, предъявляемым к жидким битумам марки БСГР 70/130 та БпСГЗ 70/130. Более высокое количество испарившегося разжижителя из жидких битумополимерных вяжущих при их термостатировании и большее значение температуры размягчения после определения количества испарившегося разжижителя свидетельствует о большей скорости формирования структуры, по сравнению с жидкими битумами. Большие значения температуры размягчения остатка у битумополимерных вяжущих, по сравнению с исходным вязким битумом, являются следствием структурирующего действия термоэластопласта, присутствующего в их составе в количестве 3 %.

Результаты сравнительных исследований влияния состава жидких битумов и битумополимерных вяжущих на свойства мелкозернистого асфальтобетона (тип В) холодного типа приведены в таблице 2.

Табл. 2.

Физико-механические свойства холодных асфальтобетонов

Наименование показателей свойств	Индекс битума				Требования ДСТУ Б В.2.7-119
	БЖ1	БЖ2	БЖ3	БЖ4	
Средняя плотность, кг/м^3	2372	2371	2363	2365	-
Водонасыщение, %	7,3	6,4	6,3	5,6	не более 9
Набухание, %	1,1	0,9	1,2	1,0	не более 1,2
Предел прочности при сжатии, МПА, при температуре 20 ^{0}С: - до прогрева	2,3	2,2	2,4	2,2	не менее 1,5
- после прогрева	3,1	2,9	3,6	3,6	не менее 1,8
Коэффициент водоустойчивости: - до прогрева	0,82	0,92	0,94	0,96	не менее 0,85
- после прогрева	0,94	0,96	0,99	0,99	не менее 0,90
Коэффициент длительной водоустойчивости: - до прогрева	0,52	0,70	0,72	0,74	не менее 0,70
- после прогрева	0,60	0,85	0,87	0,89	не менее 0,85
Слеживаемость, ударов	10	9	8	8	не более 10
Содержание битума, %	5	5	5	5	-

Достаточно высокие значения прочностных показателей всех исследуемых асфальтобетонов обусловлены гранулометрическим типом смеси, умеренной крупностью зерен щебня (фракция 5-10 мм) и присутствием в них 10 % масс известнякового минерального порошка. Асфальтобетоны на основе битумополимерных вяжущих характеризуются большим возрастанием предела прочности при сжатии после прогрева (1,6–1,7 раза), по сравнению с обычными холодными асфальтобетонами (1,30–1,35 раза), что свидетельствует о возможности более интенсивного формирования структуры таких асфальтобетонов в покрытии.

Характерной особенностью холодных асфальтобетонов на основе жидкого битума и битумополимерного вяжущего, содержащих катионное ПАВ, является более высокие значения коэффициентов длительной водоустойчивости до и после прогрева, по сравнению с бетонами на битумах без поверхностно-активного вещества. По уровню коэффициентов длительной водоустойчивости только асфальтобетон на основе жидкого битума без ПАВ (БЖ1) не отвечает требованиям ДСТУ Б В.2.7-119:2011, предъявляемым к асфальтобетонам I марки. Более низкие значения показателя слеживаемости асфальтобетонов на битумополимерных вяжущих хорошо согласуются с данными по когезионной прочности жидких битумов с добавками полимера [2]. Эффективность жидкого битума, содержащего одновременно добавку полимера и ПАВ, подтверждается высокими значениями коэффициентов длительной водоустойчивости асфальтобетона, большей интенсивностью формирования структуры в процессе прогрева и меньшим показателем слеживаемости смеси.

Литература:

1. Авласова Н.М. Строительство покрытий из холодных асфальтобетонных смесей с повышенным содержанием щебня., Труды Союздорнии. - 1969., вып. 34.,С. 180-188.
2. Волков М.И., Космин А.В. Снижение слеживаемости холодного асфальтобетона., Автомобильные дороги. - 1970., № 7., С. 14-15.
3. Жданюк В.К., Ребенок О.Е, Шевченко В.П. Сравнительные исследования когезионной прочности вязких и жидких нефтяных битумов., Вестник ХГАДТУ.– Харьков., ХГАДТУ. - 2000., вып.12, 13., С. 35 - 37.

U.D.C. 37.01+ 37.02

THE BARRIERS AND CHALLENGES TO SUCCESSFUL IMPLEMENTATION OF STEM EDUCATION IN UKRAINE

M. Byrka, Dr. of Education, Associate Prof.
In-Service Teacher Training Institute of Chernivtsi region, Ukraine

Conference participant

The problem of effective realization of a new interdisciplinary educational approach – STEM education (Science, Technology, Education, and Math) in the Ukrainian education system is studied in the article. The discussed aspects are: definition, goals and promises of STEM education, legal framework of STEM education in Ukraine. The author addresses the barriers and challenges to effective implementation of STEM education in Ukraine. The research draws upon mainly primary national and international sources in the area of the STEM education including Ukrainian legislative base. The implementation of STEM initiative in Ukrainian

educational system is a good opportunity to train the future employees with strong scientific, computer and mathematical backgrounds to succeed at the global job market in high-tech area.
Keywords: *STEM education, definition, goals and premises, legal framework of STEM education in Ukraine, barriers and challenges.*

Introduction. Modern information and technological revolution causes the emergence of new occupations in high tech area at the intersection of the most natural sciences and information technologies. The success of such future professionals mainly depends on the profound and deep knowledge in basic high school STEM-disciplines, i.e. mathematics, physics, chemistry, biology, and especially informatics that form the scientific worldview of a person. No less importance has the logical and critical thinking as an apparatus which allows a person to gather the relevant and accurate information in the continuously changing world. For that reasons, the problem of implementing the STEM-education is very vital for Ukrainian educational system as a part of globalization and integration of Ukraine in European educational community and global job marker.

The problem of implementation of the STEM Education is widely studied in a global scientific and pedagogical community in the works by R. Bybee, J. Fairweather, H. Gonzalez, J. Kuenzi, H. Kanematsu, D. Barry, M. Mataric, N. Koenig, M. Sanders, P. Williams, etc. In particular, the primer of STEM Education, the practical aspects of using Hands-On Robotics, the requirements to the today technology teacher, the advantages and disadvantages of STEM Education, and its perspectives of development till 2020 have been studied.

Instead, in Ukrainian scientific-pedagogical community this problem is revealed only by V. Sharko, thus the problem of effective implementation of STEM-education in Ukraine remains unexplored, that determines the relevance of our research.

The purpose of the article is to analyze the concept of STEM education, its goal and premises, address the barriers and challenges that should be considered and eliminated for effective implementation of STEM education in Ukraine, and recommend the principles for successful implementation of STEM initiative in Ukrainian educational institutions.

The definition, goals and premises of the STEM education. Basically the term "STEM education" is an acronym that integrates four main approaches and disciplines to education – science, technology, engineering and mathematics. The STEM label firstly was used by National Science Foundation at the end of twentieth century as a concept that refers to any action in STEM fields (Bybee, 2010).

STEM education is treated "an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy" (Tsupros, Kohler, & Hallinen, 2009).

This concept also has been defined as "a standards-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering, and mathematics (STEM) teachers, teach an integrated approach to teaching and learning, where discipline-specific content is not divided, but addressed and treated as one lively, fluid study" (Brown, Brown, Reardon & Merrill, 2011).

According to Gonzalez & Kuenzi (2012) STEM education includes educational activities in classroom and afterschool programs in the whole educational system – from pre-school to post-doctorate grade levels.

Consequently, the main purpose of STEM education is improving the value of both undergraduate teaching and learning in these disciplines according to main challenges of information society and new economy.

The evidence and promising practices in STEM education (Fairweather, 2008) related to faculty involved in this reform come from three major premises: (a) Better student learning outcomes in STEM area as main challenge of information society; (b) Higher pedagogical effectiveness of teaching STEM disciplines; (c) Variability of changes of instructional roles of faculty positions in STEM fields.

Another premise is to prepare students to future employment in some high technological areas like robotics and artificial intelligence. Mataric, Koenig and Feil-Seifer (2007) recommend robotics as a superb tool that can be implemented trough hands-on learning in any classes at elementary, middle and high school-level. The authors describe own vision of robotics application in STEM fields in K-12 schools and suggest the materials and tools as well as developed science courses that involve robotics in teaching middle school classes. The material includes lesson plans, freely distributed on the Internet, detailed workbook of robot programming exercises with illustrations and solutions, and the textbook that discovers the key concepts and principles of using robotics in the teaching subject. Therefore STEM education can be treated as a presumptive reform model based primarily on in-classroom innovation and the teaching-learning process in STEM fields as challenges of the 21st century.

However, as Bybee (2010) has mentioned, in most cases this innovation is treated only as science and mathematics, despite the fact the influence of technology and engineering increasing day by day. Consequently today STEM education should be more oriented to developing students' knowledge, skills and abilities in engineering and using of technologies. Actual topics include: designing engineering processes; discover how it works; how to use technologies; problem solving and innovation etc.

Despite all these positive facts, Williams (2011) argues that STEM education realization and support is very difficult because school curriculum has a rigid structure resistant to change (p. 27). Another impediment is staffing implications in secondary and high schools, where each teacher teaches one discipline not as in primary school, where one teacher teaches all subjects to one class, which cause a necessity to provide team teaching in secondary and high schools which requires teacher's training to implement this approach. One more problem is how the STEM subjects could relate to each other in the curriculum and to justify their places (p. 28). For those reasons, "a focus on STEM integration will not overcome the barriers, and may result in the decimation of technology as a distinct component of the school core curriculum. A STEM orientation, therefore, must be approached with caution" (p. 33).

The legal framework of STEM education in Ukraine. The legislative basis of STEM education implementation in Ukraine is formed by three main documents: The Law of Ukraine "About the Innovation Activities" (2002), The Decree of the of Minister of Education and Science of Ukraine "About the Approval of the Procedure of realization of innovative educational activities" (2000), and The Decree of the Minister of Education and Science of Ukraine "About the creation of a working group on implementation of STEM-education in Ukraine" (2016).

The first document defines the legal, economic and organizational principles of state regulation of innovative activities in Ukraine, establishes state forms of incentives and innovative processes aims to support the development of innovative of Ukrainian economy. According to this law the innovations are newly formed (applied) and (or) improved competitive technologies, products or services, and organizational and technical solutions for industrial, administrative, commercial or otherwise, which significantly improves the structure and the quality of production and (or) social services; the innovation activities are the activities aimed at use and commercialization of research results and development and causes the release of new competitive goods and services.

The second document determines the procedure of innovative educational activities in the education system. Respectively, the educational innovation is considered as first created, improved education, training, educational, managerial systems, their components, with results significantly improve educational activities.

The innovative educational activities are carried out at the national, regional levels and the level of the educational institution. At the national level innovative educational activities involve the following areas: education, training, educational, administrative systems; a basic component of preschool education, invariant component of general secondary education, national component content of vocational education, adult education content, regulatory content of higher (including postgraduate) education; the experimental curricula, textbooks, manuals, developed in the course of the experiment and results to improve education; educational technologies, forms, methods and resources of training, education and education management; scientific and methodical, personnel, logistical and financial support of the educational process in educational institutions; systems, technologies, forms and methods of leadership training, teaching and teaching staff.

In accordance to the Decree of the Minister of Education and Science of Ukraine (2016), for the purpose of innovation development of disciplines of natural and mathematical cycle, the research in education, implementation and development of STEM education in Ukraine was created a working group composed by scientific and teaching staff of the Institute of modernization of the content of education, regional In-Service teacher training Institutions, methodical staff of district instructional Institution, and teachers. The main objective of this group is to develop an action plan for implementing STEM initiative in Ukraine.

The barriers and challenges to successful implementation of STEM education in Ukraine. As every innovation, the implementation of STEM agenda in Ukraine comes across a variety of barriers and challenges.

Ejiwale (2013) identified *ten barriers* to successful implementation of STEM initiative in USA that are completely applicable for Ukrainian education system:

1. Poor preparation and shortage in supply of qualified STEM teachers.
2. Lack of investment in teachers professional development.
3. Poor preparation and inspiration of students.
4. Lack of connection with individual learners in a wide variety of ways.
5. Lack of support from the school system.
6. Lack of research collaboration across STEM fields.
7. Poor Content preparation.
8. Poor Content delivery and method of assessment.
9. Poor Condition of laboratory facilities and instructional media.
10. Lack of hands-on training for students (p. 64-69).

These barriers call a range of challenges to Ukrainian educational system in *methodological*, *management*, and *performers'* aspects.

The following describes some of the identified challenges to successful implementation STEM education in Ukraine in relevant aspects.

The ***methodological challenges*** of STEM education implementation consist of:

- The requirement to make explicit the nature of STEM education, its realization and outcomes.
- The request to develop a concept consensus and define strategies to implement STEM reform in Ukrainian education.
- The demand to develop the model of implementation of STEM education that defines the learning objectives, performers roles, curriculum content, traditional and innovative instructional techniques, classroom instruction, student and teacher activities in a classroom or laboratory, resources and results.
- The necessity to elaborate an educational technology for effective realization of STEM education in Ukraine that will implement the relevant model.
- The need to design an assessment technique and tools that determine student outcomes and perceptions according to defined learning objectives, especially with more complex ones, such as the retention of knowledge over time, the application of knowledge to solve unfamiliar problems, and commitment to lifelong learning (Fairweather, 2008).

The ***management challenges*** of STEM education implementation are:

- The demand to develop a detailed instruction plan in single settings, for a course, department, institution, and location. This plan should also include the timing of implementation of all activities and responsible persons.
- The need to operate the STEM pipeline and instruction at each Ukrainian school level – from primary to high school with focus on interaction and interrelation of teaching subjects within and across departments.
- The necessity to elaborate a mechanism of motivation in teaching and learning STEM subjects. This mechanism could increase the interest and self confidence of students in field of study, and attracting them to STEM majors in college or university.
- The requirement to make a regular monitoring to determine the current state of STEM initiative implementation results and possible problems. In case of problems appearance, the relevant activities could make to solve them.
- The request for substantial external funding to develop methodological materials, manage and assess student learning outcomes of STEM education implementation.

The ***performers' challenges*** of STEM education implementation include:

- The requirement to increase public awareness about STEM education could improve the level of understanding of effectiveness and necessity of this innovation in classroom or laboratory.
- The necessity to prepare performers who have not enough necessary knowledge and skills to effective teach STEM subjects.
- The demand to adequate performer compensation to attract and retain high-quality teachers in STEM initiative.
- The need to encourage STEM performers to provide sufficient information about the course taught, materials, and resources required for its successful implementation. Also they could detail the relevance of STEM initiative to their own professional and classroom activities.

Conclusion. The STEM education is an interdisciplinary approach that aims at integrated teaching and learning of science, technology, engineering, and mathematics on one live and fluid process to compete education the new economy reality. The main premise of STEM education is that it is a presumptive reform model that responds to mail challenges of the 21st century and information society.

The legislative framework in the field of STEM education in Ukraine is formed at the primary level and could be developed to many perspective directions.

The successful implementation of STEM initiative in Ukraine encounters several barriers and challenges. To achieve STEM education goal and objectives, we identified and described some methodological, management, and performers' challenges.

Future possible research will be devoted to define and describe the principles of effective implementation of STEM education in Ukraine and give practical examples for their using in the classroom or laboratory.

References:
1. Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding Stem. Current Perceptions. Technology & Engineering Teacher, 70(6), 5-9.
2. Bybee, R.W. (2010). Advancing STEM Education: A 2020 Vision, Technology and Engineering Teacher, 70 (1), 30-35.
3. Ejiwale, J. (2013). Barriers to successful implementation of STEM education. Journal of Education and Learning. Vol. 7 (2), pp. 63-74
4. Fairweather, J. (2008). Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education. Access mode: http://www7.nationalacademies.org/bose/Fairweather_CommissionedPaper.pdf.
5. Gonzalez, H.B. & Kuenzi, J.J. (2012). Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer. CRS Report for Congress. Congressional Research Service.
6. Kanematsu, H., Barry, D.M. (2016). STEM and ICT Education in Intelligent Environments. Intelligent Systems Reference Library. - New York., Springer. DOI 10.1007/978-3-319-19234-5.
7. Law of Ukraine. (2002). Pro innovatsiinu diialnist. Zakon Ukrainy No. 40-IV vid 04.07.2002 r. [The Document "About the Innovation Activities". The Law of Ukraine, 40-IV, dated 04 July 2002]., Access mode: http://zakon5.rada.gov.ua/laws/show/40-15.
8. Mataric, M.J., Koenig, N. & Feil-Seifer, D. (2007). Materials for Enabling Hands-On Robotics and STEM Education. Refereed Workshop AAAI Spring Symposium on Robots and Robot Venues [E-Reader Version]., Access mode: http://rrl.cse.unr.edu/media/documents/2016/Mataric-2007-536.pdf.
9. MON Ukraine. (2000). Pro zatverdzhennia Polozhennia pro poriadok zdiisnennia innovatsiinoi osvitnoi diialnosti. Nakaz MON Ukrainy No. 522 vid 07.11.2000 r. [The Document "About the Approval of the Procedure of realization of innovative educational activities". The Decree of the of Minister of Education and Science of Ukraine, 522, dated 07 November 2000]., Access mode: http://zakon2.rada.gov.ua/laws/show/z0946-00.
10. MON Ukraine. (2016). Pro stvorennia robochoi hrupy z pytan vprovadzhennia STEM-osvity v Ukraini. Nakaz MON Ukrainy №188 vid 29.02.2016 r. [The Document "About the creation of a working group on implementation of STEM-education in Ukraine". The Decree of the Minister of Education and Science of Ukraine, 188, dated 29 February 2016]. Retrieved December 29, 2016., Access mode: http://old.mon.gov.ua/ua/about-ministry/normative/5219-.
11. Sanders, M. (2009). STEM, STEM Education, STEMmania. The Technology Teacher, December/January 2009, 20-26.
12. Sharko, V.D. (2016). Naprjamy modernizaciji systemy shkiljnoji osvity v umovakh perekhodu na STEM-navchannja [The directions of modernization of the school education in the transition to STEM-education]., Access mode: http://internet-confer.16mb.com/.
13. The Institute of modernization of educational content (2016). Osnovni zavdannia viddilu STEM-osvity Instytutu modernizatsii zmistu osvity [The main tasks of the Department of Education STEM-Institute modernization of educational content]., Access mode: http://www.imzo.gov.ua/stem-osvita/.
14. Tsupros, N., Kohler, R., and Hallinen, J. (2009). STEM education: A project to identify the missing components, Intermediate Unit 1 and Carnegie Mellon, Pennsylvania.
15. Williams, P.J. (2011). STEM Education: Proceed with caution. Design and Technology Education, 16 (1), 26-35.

U.D.C. 37.016:54:373

ELECTIVE COURSES AS CONTENT BLOCK OF PROFILE TEACHING OF SCHOOL EDUCATION

G. Iuzbasheva, Philosophy Dr.
Communal higher educational establishment «Kherson academy of continuing education», Ukraine

Conference participant

Differential approach for teaching of schoolchildren at general educational teaching establishments of Ukraine is integral part of organization of qualitative school education. School teachers use different sets of instruments to solve this problem. Elective courses can be regarded as content block of profile teaching of school education. Their contents depend on the profile, which the pupil chooses, while studying at profile school. The contents of elective courses is examining on the example of such school subject as chemistry. The article is dedicated to this problem.
Keywords: *school education, differential teaching, elective courses, chemical and biological profiles.*

Key question of nowadays is orientation of system of teaching to the development of individuality, able to carry out self-dependent teaching activity, self-development and creative solving of intellectual and practical problems. In the conditions of reforming of school education differential teaching is a crucial element of pedagogical changes [1]. Observing philosophy of this question, we realize that the centre of pedagogical process is a person with his (her) individual needs and his (her) own internal world as the highest value of society's life. The significant place belongs to differential teaching while solving these tasks. Profile character can be regarded as a special mean of differential teaching. Profile teaching is realized by the way of learning of system of teaching courses – basic, profile, special and elective ones (courses to be chosen) [2].

Elective courses (courses to be chosen) are aimed to satisfy different interests of pupils, such kind of courses is in the frame of school component of curriculum. There are different elective courses at different schools using the same profile of teaching. Their set according to the themes must be supplementary to guarantee choice for pupils, and forms of organization of teaching must have active character. The main peculiarity of elective courses is in necessity of choice of some concrete courses (5 – 6 and more) by a pupil himself (herself) and in their compulsory attendance after choice that puts the pupil in the situation of self-dependent professional self-determination, creation of individual life style.

In the result of researches it was established the fact that elective courses fulfilled the following functions: 1) learning of key