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STEM EDUCATION IN LITERATURE CLASSES: IMPLEMENTATION FEATURES

Abstract. In the article there are revealed imported aspects concerning the introduction of the elements of STEM - education on literature lessons. There are presented different lofty forms of project-research activity as to realisation of STEM and STREAT on the World literature lessons. It is widened the informative sphere as to better comprehension of technique application of STEM-education through innovative methods, means and forms of teaching process organisation: hackathon, marathon, online experiments, electronic virtual laboratories, science museums, platforms for organisation of international project-research activity. There are also efficient comments that relevant introduction of this innovation will provide qualitative realisation of World literature curriculum in New Ukrainian school and will become a significant factor in the formation of the competitive school-leaver.

The rapid evolution of technologies leads to the fact that soon the most popular and promising specialists on the planet will become programmers, IT specialists, engineers, professionals in the field of high technologies, etc. In the distant future, professions will appear that are hard to even imagine now, all of them will be related to technology and high-tech production at the interface with natural sciences. It is believed that if the STEM environment is a separate republic in the educational process, separated from the humanities, then students will lose the ability to think creatively. Another letter is added in the acronym A, which stands for "art". It is wrong to emphasize only natural sciences. In addition to analytical and critical
thinking, it is also important to develop creative thinking in children! Even now, the IT business does not need robot people, but creative workers.

It is precisely this type of thinking that is well developed during properly organized and conducted humanitarian lessons. Here is the third criterion. Therefore, a modern student should not only be able to read and analyze a work, but also find in it a source of new ideas for implementation related to other sciences: mathematics, biology, geography, astronomy, computer science. With the latter, it should not be exclusively the ability to create or view presentations only in PowerPoint (a phenomenon that unfortunately exists in most schools in Ukraine). To create presentations at the modern stage, students and teachers should use Sway, Prezi, PowToon services. Nevertheless, it is the program on foreign literature that provides opportunities for studying the subject and opportunities for implementing elements of STEM education in lessons.

**Keywords:** STEM-education, STEM, STREAT, Innovation, literature, project research activity, New Ukrainian school.

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**STEM-ОСВІТА НА УРОКАХ ЛІТЕРАТУРИ: ОСОБЛИВОСТІ ВПРОВАДЖЕННЯ**

**Анотація.** У статті розкрито важливі аспекти щодо впровадження елементів STEM-освіти на уроках літератури. Презентовано різні ідеальні форми проектно-дослідницької діяльності щодо реалізації STEAM-та STREAT- на уроці зарубіжної літератури. Розширено інформаційне поле щодо кращого освітлення методики впровадження STEM-освіти через інноваційні методи, засоби та форми організації навчального процесу: хакатон, марафон, он-лайн експерименти, електронні віртуальні лабораторії, наукові музеї, платформи для організації міжнародної проектно-дослідницької діяльності. Продуктивним є зауваження про те, що правильне впровадження цієї
інновації забезпечить якісну реалізацію якісної навчальної програми із зарубіжної літератури у Новій українській школі та стане вагомим чинником у формуванні конкурентоспроможного креативного випускника школи.

Визначено, що стрімкий розвиток технологій призводить до того, що незабаром найпопулярнішими і перспективними фахівцями на планеті стануть програмісти, айтішники, інженери, професіонали в галузі високих технологій і т. д. Вважається, що якщо STEM-середовище буде окремою республікою в освітньому процесі, відокремленою від гуманітарних дисциплін, то учні втратять здатність креативно мислити. До абревіатури А додається ще одна літера, яка означає «мистецтво». Неправильно наголошувати лише на природничих науках. Окрім аналітичного та критичного мислення, у дітей важливо розвивати і творче мислення! Вже зараз ІТ-бізнесу потрібні не роботи-люди, а творчі працівники.

Саме такий тип мислення добре розвивається на правильно організованих і проведених уроках гуманітарної тематики. Тому сучасний учень повинен не тільки вміти читати і аналізувати твір, а й знаходити в ньому джерело нових ідей для реалізації, пов’язаних з іншими науками: математикою, біологією, географією, астрономією, інформатикою. Що стосується останнього, це не має бути виключно можливість створювати чи переглядати презентації лише в PowerPoint (це явище, на жаль, існує в більшості шкіл України). Для створення презентацій на сучасному етапі учням і вчителям доцільно використовувати сервіси Sway, Prezi, PowToon. Тим не менш, саме програма із зарубіжної літератури дає можливості для вивчення предмету та можливості для впровадження елементів STEM-освіти на уроках.

Ключові слова: STEM-освіта, STEAM, STREAT, інновація, література, проектнодослідницька діяльність, Нова українська школа.

Formulation of the problem. "STEM education is a series or sequence of courses or training programs that prepare students for successful employment, post-school education, or both, requiring different and more technically complex skills, including the application of mathematical knowledge and scientific concepts" [7]. "STEM education is a series or sequence of courses or programs of study that prepares students for successful studies, post-secondary education, or both, requiring different and more technical complex skills, including the application of mathematical knowledge and scientific concepts" [7].

It is with this interpretation that the Institute for the Modernization of the Content of Education begins the selection of materials on STEM education on the website. If we look into the future (it would be very easy for the heroes of many literary works), then we will see 20 professions of 2030 according to EdCamp 2017, which are actually related to the four components of STEM (S – science, T – technology, E – engineering, M – mathematics). Therefore, the key aspect of the implementation of STEM education is not only in individual lessons, but during the
entire educational process – successful employment for all graduates (both with natural and mathematical aptitudes and humanitarian ones). Therefore, the main task of the research work will be to present thesis and practical material as proof of the introduction of elements of STEM education not only in the classes of the natural and mathematical cycle, but also in the humanitarian, in particular, in the lessons of foreign literature. This issue has been investigated by many scientists from a natural-mathematical and general pedagogical perspective: I. A. Klipukhina (a modern physical experiment in the didactics of STEM-oriented learning, a digital measuring complex as a formative factor of a STEM-oriented educational environment), O. V. Barna (ways and methods of introducing STEM education into the educational process), N. O. Honcharova (use of gaming technologies in STEM education), D. V. Vasylieva (implementation of STEM approaches in mathematics lessons), O. V. Buturlina (motivational and technological readiness of participants in the educational process to implement STEM education), Berezhna T. - education in literature classes, in particular foreign literature, has not yet been the object of a separate systematic review. This determines the importance of this topic. "The acronym STEM is used to denote a popular direction in education that includes natural sciences (Science), technology (Technology), technical creativity (Engineering) and mathematics (Mathematics)" [5]. It is with this interpretation that the Institute for the Modernization of the Content of Education begins the selection of materials on STEM education on the website. When looking into the future (it would be very easy for the heroes of many literary works), then let's see 20 professional 2030 according to EdCamp 2017, which are actually related to the four components of STEM (S – science, T – technology, E – engineering, M – mathematics). Therefore, the key aspect of the implementation of STEM education is not only in individual lessons, but during the entire educational process – successful employment for all graduates (both with natural and mathematical tasks and with humanitarian ones). Therefore, the main task of the research work will be to present thesis and practical material as evidence of the introduction of elements of STEM education not only in the concepts of the natural and mathematical cycle, but also in the humanitarian, in particular, in the lessons of foreign literature. This issue has been researched by many scientists in the science-mathematical and general pedagogic course: Klipukhina I.A. (modern physical experiment in the didactics of STEM-oriented learning, digital measuring complex as a formative factor of STEM-oriented educational environment), Barna O.V. V. (ways and methods of introducing STEM education into the educational process), N. O. Honcharova (use of game technologies in STEM education), D. V. Vasylieva (implementation of STEM approaches in mathematics lessons), O. V. Buturlina. (motivational and technological readiness of the participants of the educational process to implement STEM education), Berezhna T.V. L. (I. (STEM education as an element of the teacher's professional competence), S. L. Horbenko (STEM education and gifted youth), I. Stetsenko (STEM education for preschoolers) and
others. At the same time, it is the introduction of STEAM or STREAM elements of education on "The acronym STEM is used to denote a popular direction in education that includes natural sciences (Science), technology (Technology), technical creativity (Engineering) and mathematics (Mathematics)" [5].

And as a continuation: This is a direction in education in which the natural science component + innovative technologies are strengthened in the educational programs. Technologies are used even in the study of creative and artistic disciplines. And as a continuation: This is a direction in education, in which the natural and scientific component + innovative technologies are strengthened in the educational programs. Technologies are needed even in the study of creative, artistic disciplines.

Analysis of the researches. Haven't we, philologists, with many years of work experience, been convinced that precisely thanks to properly organized project-research work in literature classes, we get an interesting and creatively useful product. Right now, in order not to get lost in the whirlwind of innovations and integrations (we have a bitter experience), we philologists should not stand aside, but start introducing elements of STEM (or varieties of STEAM- or STREAM-) education in our lessons. Then we will always be afloat with literature, and we will be able to draw attention to the natural and mathematical sciences through our fascination with the artistic text, because it was not for nothing that the famous mathematician A. Pringsheim remarked: "In true mathematics, there is always something from an artist, an architect, and even a poet." The second element of the formula for the success of STEM education for humanitarians is relevance and importance.

The rapid evolution of technologies leads to the fact that soon the most popular and promising specialists on the planet will become programmers, IT specialists, engineers, professionals in the field of high technologies, etc. In the distant future, professions will appear that are hard to even imagine now, all of them will be related to technology and high-tech production at the interface with natural sciences. It is believed that if the STEM environment is a separate republic in the educational process, separated from the humanities, then students will lose the ability to think creatively. Another letter is added in the acronym A, which stands for "art". It is wrong to emphasize only natural sciences. In addition to analytical and critical thinking, it is also important to develop creative thinking in children! Even now, the IT business does not need robot people, but creative workers.

It is precisely this type of thinking that is well developed during properly organized and conducted humanitarian lessons. Here is the third criterion. Therefore, a modern student should not only be able to read and analyze a work, but also find in it a source of new ideas for implementation related to other sciences: mathematics, biology, geography, astronomy, computer science. With the latter, it should not be exclusively the ability to create or view presentations only in PowerPoint (a phenomenon that unfortunately exists in most schools in Ukraine). To create
Presentations at the modern stage, students and teachers should use Sway, Prezi, PowToon services. Nevertheless, it is the program on foreign literature that provides opportunities for studying the subject and opportunities for implementing elements of STEM education in lessons. The works of Jules Verne, Antoine de Saint-Exupéry, Isaac Asimov, Jonathan Swift, Bertolt Brecht, Guillaume Apollinaire are far from a complete list of the implementation of STEM while working with a work of art. In no case should this go beyond the available framework and be a step towards the integration of subjects (the importance of the self-sufficiency of the subjects "Ukrainian literature" and "foreign literature" was repeatedly mentioned in the statements of VGO, in particular UAVZL, speeches of leading experts, in the columns of periodicals). But a step towards a better understanding and interest of students in literature - yes! The fourth criterion is reasonable integration [2].

The objectives of the article. The research work "Birds in oral folk art" in the lesson of foreign literature and in extracurricular activities will give impetus to the construction of the birds of the future (perhaps a work), which should absorb all positive features and become a reliable assistant for a person, his psychology (the name of the project "Firebird robot". 5th grade). Work in the projects "Gloves for Gerda" or "Gifts of the Snow Queen" will give an opportunity to activate the work of fifth-graders in a new environment and implement many interesting natural and technological processes. Students will not only design an ornament for the heroine's gloves, but also create floral compositions.

When studying John Keats's poem "On the Grasshopper and the Cricket", it is interesting to use agamography - pictures depicting the change of seasons. Also, the comparative melody of the jumping grasshopper and the cricket is another element of STREAM education in literature classes. Studying the navigation, flora and fauna of Africa together with the characters of "The Fifteen-Year-Old Captain" by Jules Verne, drawing the route of the "Pilgrim" using the resources of thinglink.com or glogster.com (project name "Pilgrim". Grade 6) is not only interesting, but and scientific and cognitive. Robert Shackley's work "The smell of thoughts" provides opportunities for the implementation of another innovation - robotics. Students can launch rockets or other machines from a coordinate system, using mathematical and physical knowledge and skills. The theories of the origin of the world and the origin of man are perfectly superimposed on the program material from foreign literature in the 6th and 8th grade during the study of myths and the most ancient monuments of literature [3].

Presentation of the main material of the study. With the help of piktochart.com, infogram.com or creately.com resources, you can easily explain the historical period that is the background of Walter Scott's work "Ivanhoe" (the name of the project "Knights of the Future". 7th grade) or look into the scientific museum of castles and fortresses. It is appropriate to make creative theatrical masks: tragic and comic (8th grade), studying the literature of Ancient Greece and Ancient Rome. Also interesting is the study of the work of Miguel de Cervantes "Don Quixote".
Building and designing windmills is an unlimited imagination of pupils. Paper, wooden, plastic, fabric windmills will be the final product of the Don Quixote Windmill project in the 8th grade. Ninth graders will be interested in studying Jonathan Swift's work "Gulliver's Travels", through mathematical calculations about how much food the Man-Mountain needs, exploring the geographical location of the country of Lilliput and the peculiarities of the biological clock of the Man-Mountain, to develop not only logical, but also creative thinking. Alexander Pushkin's biography can be suggested to be studied through the project-research activity "Geography of the cities of the Russian writer". And the work "The Hero of Our Time" by Mykhailo Lermontov provides an opportunity, through "telescopic tasks", contemplating mountain landscapes and tasting the mineral water of "Yesentuki", to work out the plot and psychological features of the characters [4].

With parallel straight lines and with the help of templates of various geometric shapes, you can arrange Hobsek's room (Project "Hobsek's Room". Honore de Balzac "Hobsek") or Nora's house (Project "Nora's House". Henrik Ibsen "Doll's House"). It is interesting to read Guillaume Apollinaire's poem "Miryabeau Bridge" and try to construct it in your imagination (and for the residents of Gurtkov, it is a great opportunity to build a bridge on a large scale), preparing you for the realization of a profession related to bridge construction or the most modern one - urban planner. And it is even more interesting for eleventh-graders (and not only) to create word clouds (tags) for one or another poetic work thanks to the resources wordard.com, imagechet.com, tagxedo.com (the name of the project is "Mirabomist". 11th grade). Over time, by improving the methodology of teaching literature with elements of STEM education in classes, it will be possible to access publicly available global platforms for organizing international project-research activities in humanitarian subjects. The fifth criterion is the implementation of STEM education in literature classes through project-research activities. Learning is not just a transfer of knowledge from a teacher to students, it is a way of expanding consciousness and changing reality. It is possible and necessary to change reality precisely through the connection with a work of art.

Creativity, which includes creative and artistic disciplines (industrial design, architecture and industrial aesthetics, etc.) is actively implemented in literature lessons. The fact that the future should be based exclusively on science will hardly surprise anyone. The future should embody the synthesis of science and art. And it is time for us, philologists, to think about how to educate the best representatives of the future, while preserving the love for the artistic work. Literature lessons are also a good background for patriotic education.

The goal of STEM education is employment in the territory of the native country! The sixth proof is obvious – patriotic education in literature classes through elements of STEM education. According to American scientists, an attempt to activate education only in the direction of science without the parallel development of Arts-disciplines can lead to the fact that the young generation will lose their
creativity skills. It is the interactive forms of work during the study of material from literature that should become tangential to the introduction of elements of STEM education, as well as to STEAM or STREAM education, which are branches of the general term. IT business now needs creative people, and these thinking persons will develop only during properly organized humanitarian subjects [5,19-21].

It is clear that the introduction of STEM education will change the economy of our country, make it more innovative and competitive. And the fact that through the involvement of students in the STEM field in literature classes will give the opportunity to be competitive, culturally active, and creative school graduates - good practice! By the way, as billionaire Mark Cuban notes: "Today, there is no need to teach a young person about finance, because any analyst can calculate financial data using an algorithm. But after 10 years, the demand for philologists, philosophers and other humanitarians will increase sharply" [9,12-21].

Another aspect of introducing any innovation into the educational process is the moral and psychological readiness of the teaching staff. Only when every teacher understands that student gadgets are not a toy, but an important auxiliary object in the lesson, that the teacher should not retell the material of the lesson, thinking that the more I say, the better they will remember, but on the contrary, be able to direct the student's work to search and the desire to learn to search for the necessary information independently or in a group, not only from the textbook, that to conduct a modern effective lesson, the knowledge that teachers received as students in higher education institutions or 5 years ago at Intel or Microsoft courses is not enough, and self-improvement is necessary all the time and to develop one's own creativity, that integration should be reasonable and understandable to every teacher - then the process of introducing new things into the general educational environment will be successful, effective and efficient [7, 10-21].

**Conclusions and prospects for further research.** The process of creating STEM curricula begins with the identification and detailed elaboration of the content and logistics of the formation of STEM - competence as a dynamic system of knowledge and skills, skills and ways of thinking, values and personal qualities that determine the ability to innovate. The next stage is a careful selection of appropriate exercises, project tasks in the form of problem tasks for use in educational activities. It is worth noting that during the formation of the content of education on the basis of STEM, various variants of interdisciplinary approaches with different degrees of integration of disciplines are used, namely: multi- and interdisciplinary, and especially transdisciplinary approach, which contributes to obtaining new knowledge by synthesizing the resources of several disciplines. As mentioned above, the STEM approach differs from traditional educational models in that it focuses on the creative solution of everyday life problems, real problems that need to be solved, and thus forms and comprehensively develops scientific and engineering thinking.
We suggest that you familiarize yourself with the possible forms of submission and the requirements for the registration of the results of the STEM project [8, 9-21].

The presentation of the results of the STEM project involves indicating, regardless of the form of presentation, the main components: the goal, hypothesis, tasks, materials and equipment, the methods used, the process of testing the hypothesis, the results obtained, conclusions, a list of the literature used, further directions of research, which are relevant for implementation in the future. After publishing the results of the STEM project (presentations, discussions, answers to questions), the participants have the task of analyzing, comparing, evaluating the results in accordance with the received comments or suggestions.

Self-evaluation can be carried out in various forms, one of which is keeping a diary during the implementation of the project, in which its course is recorded, data obtained and corresponding conclusions are recorded, critical moments and ideas for their solution are analyzed, and the results obtained during the implementation of the project are evaluated. Such a diary will help to convince the jury members of the independence and originality of the completed project, provided it is submitted to the student project competition. The main criteria for the external evaluation of the STEM project (expert evaluation of the results) are: relevance of the research problem; the correctness of the use of research methods and data processing methods; development (level of disclosure) of the problem; argumentation of decisions made, formulation of conclusions; ethics of registration of activity results (compliance with norms); activity of each project participant; collective nature of the decisions made, etc. (for group and collective projects); presentational qualities of the project participants (mastery of the research problem, ability to answer the questions, brevity and reasoning of the answers, etc. [9].

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