



## ОБУЧЕНИЕ ИНФОРМАТИКЕ TEACHING COMPUTER SCIENCE

DOI 10.22363/2312-8631-2022-19-2-157-164

UDC 373.1

Research article / Научная статья

### Engineering design as a general area of study of informatics at the school of International Baccalaureate

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**Abstract.** *Problem and goal.* The features of the work of the direction of engineering design are revealed, taking into account the peculiarities of teaching under the International Baccalaureate program as part of the school curriculum to prepare students for the choice of a future profile of education in high school. Objectives: 1) to analyze the features of the work of this academic subject, taking into account the specifics of teaching the subject group “Design” within the framework of the International Baccalaureate program; 2) describe the features of this direction; 3) sum up the results of the work and development prospects of students studying according to the presented curriculum, taking into account the peculiarities of the implementation of this curriculum. *Methodology.* A set of research methods was used: analysis of regulatory documents, determination of priority tasks for teaching this area, work experience. *Results.* The experience of working with secondary school students within the framework of the presented direction is analyzed, features and opportunities for further work are identified. *Conclusion.* Education taking into account the implementation of the features of the International Baccalaureate program allows students to prepare for the choice of a future profile (future profession), get acquainted with information opportunities, and prove themselves when working with various information technologies at an early stage of education.

**Keywords:** engineering design, programming, robotics, International Baccalaureate, computer science training

**Article history:** received 2 December 2022; accepted 22 February 2022.

**For citation:** Anikanova KI. Engineering design as a general area of study of informatics at the school of International Baccalaureate. *RUDN Journal of Informatization in Education*. 2022;19(2):157–164. <http://doi.org/10.22363/2312-8631-2022-19-2-157-164>

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## Инженерный дизайн как эффективное направление изучения информатики в школах Международного бакалавриата

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**Аннотация.** *Проблема и цель.* Выявляются отличительные черты работы направления инженерного дизайна с учетом особенностей обучения по программе Международного бакалавриата в рамках школьной программы для реализации подготовки учащихся к выбору будущего профиля обучения в старших классах. Цели: 1) проанализировать работу данного учебного предмета, принимая во внимание специфику обучения предметной группы «Дизайн» в рамках программы Международного бакалавриата; 2) описать особенности данного направления; 3) подвести итоги работы и перспективы развития учащихся, обучающихся по представленной учебной программе. *Методология.* Использован комплекс методов исследования: анализ нормативных документов, определение приоритетных задач обучения рассматриваемого направления, опыт работы. *Результаты.* Проанализирован опыт работы с учащимися средней школы в рамках представленного направления, выявлены особенности и перспективы дальнейшей работы. *Заключение.* Обучение с учетом внедрения специальной программы Международного бакалавриата позволяет учащимся подготовиться к выбору будущего профиля (будущей профессии), познакомиться с информационными возможностями, проявить себя при работе с различными информационными технологиями на раннем этапе обучения.

**Ключевые слова:** инженерный дизайн, программирование, робототехника, Международный бакалавриат, обучение информатике

**История статьи:** поступила в редакцию 2 декабря 2022 г.; принята к публикации 22 февраля 2022 г.

**Для цитирования:** *Anikanova K.I. Engineering design as a general area of study of informatics at the school of International Baccalaureate // Вестник Российского университета дружбы народов. Серия: Информатизация образования. 2022. Т. 19. № 2. С. 157–164. <http://doi.org/10.22363/2312-8631-2022-19-2-157-164>*

**Problem and goal.** Modern education undergoes significant changes every year to improve and diversify the educational process. Now, not a single training session takes place without the use of information resources that allow diversifying the educational process and help students express themselves in certain areas [1].

In this regard, each educational institution builds its own curriculum, various new areas, subjects, opportunities for cooperation with universities, colleges, etc., appear. Traditional lessons are being replaced by lessons in laboratories, with the use of modern information technologies, involving specialists from various fields. This allows students to immerse themselves in the work environment and feel the significance of the direction they have chosen.

But at the same time, these effective areas of work are different for each educational institution, because the implementation of all projects requires a large

amount of material and physical resources. Therefore, institutions begin to prepare students from an early age for the features of the future curriculum of the school.<sup>1</sup>

Hence, the problem for educational institutions is the choice and implementation of effective areas that will be reflected in various academic disciplines.

**Methodology.** The analysis of the Federal State Educational Standards and the standards of the International Baccalaureate program (as varieties of educational standards) was carried out. Features of work in each standards, similarities, differences, psychological features of work are revealed.

The work in the educational institution “School No 1575,” which implements work according to two standards (middle and high school), is analyzed. A collection of students’ works in various information areas, which are reflected in their implementation in this discipline, was carried out.

**Results and discussion.** In many educational institutions (in particular, in Moscow), there is an early profiling of classes in various areas: mathematical vertical, engineering, information, humanitarian, media classes, and others [2]. This contributes to the development of early profiling and the choice of a future profession by students.

In this regard, educational institutions find opportunities to participate in various educational programs for the purpose of development, exchange of experience, search for new personnel.

Profile education is a special kind of differentiation and individualization of education. It implies the creation of conditions for the formation of cognitive interest within a certain direction. Many educational institutions are considering division into profiles already from the 8th grade, if the material base of the school allows it [3]. Students can choose one or another profile of study, depending on the curriculum. Most schools are now seeing the emergence of special classes equipped with the necessary equipment, technologies that provide students with the opportunity to get acquainted and immerse themselves in learning with technologies that can later become part of their profession.

In addition, in many educational institutions, training comes with the introduction of elements of the International Baccalaureate program, which also considers various subjects and directions that should help students in determining their future profession. Features of teaching under this program allow students to develop the qualities of independence, critical thinking skills, research skills. These areas are considered in 8 subject groups, where each subject reflects a different area of study: the humanities, languages, creativity, etc.<sup>2</sup>

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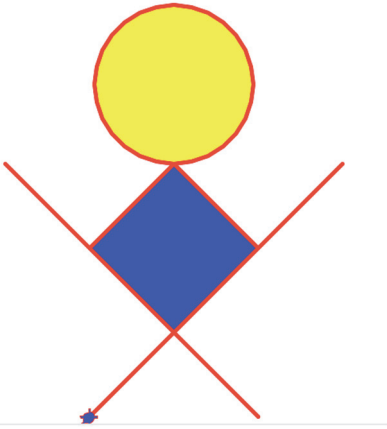
<sup>1</sup> Shatrovskaya T. International Baccalaureate at school: what, why and for whom. *Mel.* 2 February 2017. (In Russ.) Available from: [https://mel.fm/vospitaniye/sovety/824937-international\\_baccalaureate](https://mel.fm/vospitaniye/sovety/824937-international_baccalaureate) (accessed: 20.02.2022).

<sup>2</sup> The Program of the Main Secondary School. Design Guide. Geneva: Organization of the International Baccalaureate; 2014.

One of these areas is the technical direction, one that is currently gaining immense popularity among students. In the International Baccalaureate, these subjects belong to the “Design” group, which includes the use of various information technologies and resources by students to prepare technical and engineering projects [1].

This academic discipline includes training from grade 5, and is a continuation of the study of computer science at school.

As part of studying at the main school of the educational institution “School No 1575,” the subject “Design” considers the study of the basics of robotics and programming, allowing students to get acquainted with the possibilities of the modern information world from an early age. This subject at the school is called “Engineering Design,” as it is associated with the demand and relevance of education in future engineering classes. Classes are held once a week for each of the directions [4].



**Figure 1.** Image created by a 5th grade student in a programming lesson

In programming, students get acquainted with the possibility of writing programs in Python in the IDLE programming environment: solving various mathematical problems, using conditional operators, loops, strings, lists, creating games using the turtle library, etc.<sup>3</sup> Due to the fact that in elementary school students receive basic knowledge on the topic “Algorithm” and worked with various Performers, these classes are productive, homework is done with pleasure. In addition, they receive basic knowledge of geometry, get acquainted with various new geometric shapes, their characteristics. Some students think over independent drawings and demonstrate their results among classmates (Figure 1). Students develop logical thinking skills, learn to plan the progress of the task, prepare to create projects within this direction [5].

In the process of completing tasks, students can test, evaluate and improve their knowledge in programming in practice, learn to solve tasks. Demonstrate their technical skills, the ability to explain changes made to their program code and present the solution as a whole, as well as describe their success with the idea and how the solution can be improved. An analysis of the results obtained will give an understanding that the implementation of the goal in creative activity is a time-consuming, but interesting process.

Due to the fact that work is carried out on computers, and training begins from the 5th grade, this contributes to the development of initial computer skills for those who do not have the opportunity to get them at home. Students can work both from phones and tablets [6]. Since this academic year, a virtual laboratory has appeared in the resources of the library of the Moscow Electronic School,

<sup>3</sup> Tyrina LV. *Modern technologies in modeling*. 11 February 2016. (In Russ.) Available from: <http://uo-mr-pechora.com.ru/?p=551> (accessed: 20.02.2022).

where you can also work with writing code in various programming languages, with the ability to check and send the program to the teacher [7].

The second area of “Engineering Design” is robotics. Its study is now very promising and important, as it is one of the areas of scientific and technological progress. In these classes, students work with various types of constructors: Lego EV3, Vex and others [8]. They create and program various controlled devices, acting as young scientists, conducting simple studies and recording their results (Figure 2). An analysis of the results obtained will give an understanding that the implementation of the goal in creative activity is a time-consuming, but interesting process.



**Figure 2.** Educational work of 6th grade students in a robotics lesson

The course is based on a holistic image of the surrounding world, which is refracted through the result of students’ activities. Every year, the requirements for modern engineers, technicians and ordinary users are increasing, in terms of their ability to interact with automated systems. The intensive introduction of artificial assistants into our daily lives requires users to have up-to-date knowledge in the field of informatization.

In the process of completing the task, students update their knowledge on the structure and operation of the simplest mechanisms, learn to distinguish between types of mechanisms and types of levers, and also learn to master additional sources of information on their own. Students must solve problems, which involves the use of their own knowledge and experience, the accuracy and logic of the presentation of thoughts, the ability to use appropriate terminology. Conducting an assessment task in this discipline will enable everyone to feel in the role of a participant and an expert, to consolidate knowledge on the subject. The exchange of views and possible discussions on the results will contribute to the formation of the worldview of the child.

In addition, students receive basic knowledge in working with 3D modeling by working in the Tincercard program. In the later stages of learning, student work focuses on the design problem, which is to solve a specific design situation for a specific audience. At the same time, the results of this work completely de-

pend on the knowledge, skills and abilities that students received at the initial stages of the course.

These activities are giving positive results. Students with a high level of motivation receive additional individual projects and assignments to implement their creative ideas. Students actively participate in the school competition of design and research works “Discovery,” where they can already apply the acquired skills in programming and robotics lessons, solving problems of a different nature [9]. It is noted that every year projects become more complicated and interesting, many students independently study additional possibilities of engineering areas and create complex projects, which are ready-made programs, applications and complex models, both 3D and from other material [10]. In School No 1575 every year there are winners of international competitions, in particular World Skills, which allow talented and interested children to show everything they could learn and improve their skills in working with these areas.<sup>4</sup> Also, there is an opportunity to prove oneself in the pre-professional Olympiad, which makes it possible to obtain additional USE points [11].

**Conclusion.** Using the example of the implementation of the project for future engineering and information classes at School No 1575, preparation for which is carried out from elementary or secondary school, it is possible to trace and identify the opportunities for students to choose their future areas of study and work, as well as participate in world-class competitions that provide development prospects. Teaching the discipline “Design” within the framework of the International Baccalaureate program using educational electronic resources contributes to a significant increase in the interest of primary school students in studying this subject area and, in the future, a more conscious choice of the direction of training in the field of informatization.

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