Functional Zoning of Modern Educational Complexes

A A Kuznetsova¹, I V Zhdanova¹, N D Potienko¹
¹Architecture of Residential and Public Buildings Chair, Academy of Architecture and Civil Engineering, Samara State Technical University, Molodogvardeyskaya str., 194, Samara, 443001, Russia
E-mail: amore_86@mail.ru

Abstract. This study aims to investigate the current trends in educational facility design both in Russia and abroad. It highlights the existing government programs intended to standardize and regulate the architectural design of educational establishments. The authors identify the specifics of large educational buildings' functional structure and discuss a tendency towards merging several levels of education into major functional units. Examples of schooling facilities in some foreign countries reaffirm the relevance of multifunctional educational complexes. Different building units are grouped into clusters using communicative public spaces. Conclusions have been drawn as to the importance of larger educational facilities integration into various urban environments. The study systematizes functional units that keep changing during the building's life cycle and explains the framework behind the functional replacement model. It appears expedient to use this model when designing educational facilities of different capacities.

1. Introduction
The Federal Target Investment Program (FTIP) lays the groundwork for urban development in Russia and determines budget allocation for all aspects of city management, including housing and infrastructure development. The Program has been designed to provide for integrated area development and promotes the construction of kindergartens, schools, outpatient clinics, hospitals, recreation areas, major sports clusters, libraries, museums, theaters, etc., alongside residential housing. Throughout history, as different architectural styles emerged, the city landscape changed considerably. The number one priority was to provide the population with individual housing units and minimal social infrastructure. The enhancement of the urban quality of life was sidelined by other issues. At this point, however, the development of a well-balanced and comfortable urban environment that accounts for diverse community needs and ensures high comfort of living has been identified as a priority area for municipal authorities. In this regard, educational facilities are an indispensable part of social infrastructure [1-3].

2. Materials and methods
The general education sector in Russia is now facing a number of significant challenges such as learning in two or three shifts, school overcrowding, lack of educational equipment, and the emergency state of some school buildings (the deterioration level of over 15,000 schools exceeds 50%) [4]. Moreover, recent times have witnessed considerable differences in the structural design of school facilities in
metropolitan and peripheral areas. To address the existing issues at the legislative level, Russia's Ministry of Education and Science has launched the National Education Project.

This study draws on academic literature on the general issues of both educational facilities design and planning and the educational sector development in general (Stepanov V.I., Barabash M.V., Morgan N.A., Klochko A., Gelfond A.L., Vavilova T., Zhdanova I.V., Kuznetsova A.A., Generalova E.M., etc.). The concern for the professional architectural community is to develop an integrated approach for the general education facilities design on the entire territory of Russia. Thereupon, it seems appropriate to review and juxtapose the global education development trends, Russia's demographics, regulatory documents, and modern domestic practices and initiatives to lay the groundwork for an integrated design model.

This study aims to review and juxtapose the global education development trends, as well as to identify the design and planning approaches to the construction of school facilities' functional units. Therefore, the subject being analyzed is functional zones as determined by dominant teaching methodologies and the approaches taken to combine separate functions into single design units.

3. Results

A general education building is the most heavily regulated capital construction project, and therefore its structural design requires special attention. As for the efforts aimed at achieving the goals set by the National Education Project, the following measures can be highlighted: private-state partnership development, the introduction of alternative education forms (the Modern Digital Educational Environment and Growth Point projects), conceptual design of a new educational environment, and existing school facilities upgrading (functional interior renovation, adding extensions of varying size to existing buildings). Moreover, there is a growing tendency in many of Russia's federal subjects to build larger educational facilities (for 855 to 2500 students), and the expediency of this strategy is evidenced by global architectural practices. Let us consider the specifics of today's multifunctional educational complexes [5-7].

The idea of constructing integrated educational facilities has been discussed in Russia since the 19th century. In 1832, a school for 10 boys where children started their education at the age of 4 was opened on the premises of the Gatchina orphanage. Since 1837, the school was able to accommodate 120 boys aged 4-10 and also functioned as a boarding house [8]. Most educational complexes today include preschool and school facilities that are located at immediate proximity to each other or on the territory of a larger complex [9]. Having analyzed Russia's existing regulatory framework and today's structural design examples, it is possible to identify three types of functional units: the pre-school and elementary school unit, the middle and high school educational unit, and the general-purpose unit for the middle and high schools.

The main idea behind this model is to organize the free time of children and adolescents. The characteristic feature of a full-time school is the combination of a compulsory curriculum with free choice activities, including studies at home and out-of-school educational facilities. Let us review the most vivid examples of educational complexes design and planning in Russia. In September 2019, Russia's largest school was opened in Moscow on the premises of the former Likhachev Plant (Zil.). The facility was designed to accommodate 2500 students and has been installed with state-of-the-art educational equipment for the comprehensive physical and aesthetic development of every child. The four-storey building consists of three units: the first one is for the elementary school, the second — for the middle and high schools, the third one — for social and sporting activities. The social and sporting activities unit comprises Quantorium, a technology park where students can take advanced courses in science and engineering and develop their technical proficiency (figure 1) [10].
Figure 1. An educational complex for 2500 students, Moscow (Russia).

A general education complex for 1700 students was built in Kaliningrad. The building was equipped with all the necessary facilities for pre-school activities such as recreation zones, a conservatory laboratory, shooting range for kids, robotics classroom, gym, media center, dance hall, and a plant cultivation classroom. The complex was designed for schools operating on a single-shift basis. The school will host various study groups, workshops, and athletics classes for both its students and students from other general education establishments of the city (figure 2).

Figure 2. The design of an educational complex for 1700 students, Kaliningrad (Russia).

By 2022, a network of multilingual schools teaching Russian, Tatar, and English will be built in the Republic of Tatarstan. According to the design plan, a 25 thousand square meters three-story school building will house 51 classrooms, ten laboratories, two swimming pools, two sports halls, an assembly hall, library, and canteen. The overall design concept for this complex was to attract the most talented and gifted students from all over the Republic. A boarding house accommodating up to 240 residents is planned to be built for this purpose. Multilingual educational complexes have been designed to provide for competitive education in Russian, Tatar, and English and facilitate the use of cutting-edge teaching practices. The Republic's education experts have concluded that an inclusive curriculum spanning pre-school to high school level results in a more effective education system [11-12].

When considering a global experience in educational facilities design, Asian learning establishments deserve particular attention since educational systems in Russia and Asian countries are a lot alike and have the same number of levels and stages. In 2019, an educational facility for 2500 students, which is the average building capacity in China, was put into service in Shenzhen (China). The building is composed of three distinct units: the pre-school department, elementary and middle school level, and high school. The units are integrated into a compact building structure and connected through an open
courtyard in the summertime and a forum space during the cold season (figure 3A). An enclosed forum also serves as a communication area between separate units of an educational facility for 1700 students in Beijing (China, High school, 2019). However, in contrast to the aforementioned establishments, the school building under consideration was designed to accommodate only high school students and can be divided into several functional units: natural sciences, technical education, liberal arts, and sports education (figure 3B) [13-14].

Figure 3. Educational complexes of different capacities (A – for 2500 students, B – for 1700 students)

Typical examples of educational facility design in Europe are crossover schools combining two levels of education such as middle school and high school or pre-school and elementary school. Functional units in such school buildings have a variety of structures and are characterized by flexible design solutions and versatility. One of the most prominent examples of a multi-purpose interior space is Brighton College (United Kingdom, Brighton, the OMA architectural firm, 2020). Despite its compact structure, the college building features a well-developed functional framework: the Sports department is integrated into the overall campus space, while the classrooms in the Science department have floor to ceiling windows, which makes it possible to use the solar spectrum effectively and consistently in the educational process [15-17].

The analysis of the best international and domestic practices in educational facilities design and construction has shown that merging fully-developed functional units into one linear volume through buffer (forum) spaces is a promising area for the development of educational establishments design. Various structural design examples we have considered feature multi-purpose interior space, open courtyards bolstering interaction in the educational environment, and sports facilities integrated into the main building structure.

4. Discussions
The study revealed the main approaches to the functional organization of educational complexes' interior such as merging at least two independent educational units, introducing multifunctional open spaces into the educational environment, and using enclosed and open forums as a connective space. The analysis of theoretical fundamentals, as well as the domestic and international experience in educational
facilities design has revealed an apparent pattern of combining different functions at the design level, which resulted in the emergence of integrated communication areas. In its turn, this has made it possible to identify modern development trends as regards educational facilities’ functional space and to lay down the functional replacement model. The latter is based on replacing conventional educational spaces with multifunctional units. Among the main elements of this model are sitting stairs (stairs that simultaneously perform communicative and recreational functions), lockers, co-working spaces instead of conventional libraries that take on the function of attracting and educating young people, and playrooms in elementary school. This becomes especially relevant as children are now spending more time in school under the new standard. A new functional unit has conditioned the emergence of elementary classes blocks (ECBs), i.e. transforming modules encompassing pre-school education and elementary education up to the second year of study. Playrooms help children disabilities or special developmental needs adapt to the elementary school curriculum and create a favorable psychological and emotional environment. Special attention in modern educational complexes is given to transformable structures and partitions (noise blocking curtains, stands in the gym, etc.), which allows for assigning new functions to conventional educational spaces and makes them more comfortable for students; laboratory classes, i.e. facilities for practical science lessons equipped in accordance with current educational standards and author's pedagogical methods (figure 4).

Figure 4. The functional replacement model. The pre-school unit is transformed into the elementary school department.

This study's findings can be used in experimental design and when creating design assignments for students studying for their bachelor's or master's degree in architecture. The above-mentioned shows that using the functional replacement model in the educational facilities design and construction is a promising area that allows creating a high-grade social infrastructure facility for any urban planning conditions.
5. Conclusions

Thus, in a modern urbanized environment and under different urban planning conditions and existing educational standards, it becomes expedient to design multifunctional educational facilities of large capacity. At the same time, such complexes can be open to the residents of surrounding buildings and urban formations in the full-day mode [18-20]. Bringing the functional replacement model into the architectural practice will result in building more flexible, modular-type educational buildings capable of adapting to the changing social and demographic environment in a given region. It should be noted that studying the patterns behind the functional organization of individual zones that lie at the core of the functional replacement model requires detailed examination and is a promising area of research.

6. References

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