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Methods of ensuring comfort and quality in the design of ecological and safe school furniture

Abstract

Main problem: The functional state at the physiological, psychological and behavioral levels depends on the student's working posture and affects the fatigue and performance of schoolchildren. Each new development of school furniture will undergo several test cycles. None of these cycles can give a final version of the comfort and safety of the equipment. The evaluation of school furniture takes place in several directions: compliance with building regulations and standards in accordance with age and other physiological parameters, secondly, the quality, durability and strength of modern materials, as well as the design of the form of which will provide aesthetic needs and provide a number of functions that contribute to the development and correction of children during classes in various disciplines.That is why the main context of this article is the work on identifying an increase in the period of productive working capacity in children engaged in a new model of a school desk that meets the basic ergonomic requirements.

Purpose: The purpose of this article is a hygienic assessment of the impact of the ergonomic parameters of the workplace, namely furniture, on the physiological, psychological and behavioral levels of the functional state of schoolchildren and the state of the musculoskeletal system.

Methods:To achieve the scientific results of this study, the methods of information and analytical, professional graphic, ergonomic methods, modeling method, questionnaire and experiment were used.

Results and their significance: In the process of analyzing the information, the material of scientific research was studied and classified, which substantiates the methods of analyzing the functional feasibility, environmental safety and constitutional justification of school furniture created on the basis of innovative technologies including special technical achievements that contribute to the improvement of students' performance, interest, passion and self-development. The author's classes and tables are proposed in which the data of questionnaires and typologies of various principles of artistic design are presented, contributing to the creation of unique and at the same time ergonomic and ecological and safe furniture for schools.

Keywords: hygiene, ecology, safe furniture, school furniture, ergonomics, innovative technologies.

Introduction

The improvement of school furniture is an acute and timely issue. New materials and lighter and at the same time durable form the appearance of classrooms. In most cases, this is the standard form of a table and chairs laminated with light walnut chipboard panels. Ergodesign is an integrated into the design methodology, it is a scientific research analysis in which the concepts of convenience and usefulness of a new design object for human life are realized. There are two directions of practical application of the results of ergonomic research: design and corrective.The design board is used when designing a new facility. Corrective – for partial modernization of an existing facility. In this practice, problems are identified in which the tasks of modern planners and designers are summarized:

Expand the range of standard furniture depending on the functional tasks of the lesson;

To study the factors contributing to an increase in the performance of students and reducing irritation from sedentary activity;

To strengthen the factors of aesthetic appeal of school furniture through technical innovations and expansion of constructive possibilities.

Studying the directions of research in the design of school furniture, we studied the works of scientists, designers who highlighted various problems of school furniture in scientific articles:

«Hygienic assessment of the influence of ergonomic parameters of student furniture on the functional state of the child» was considered by Degtev S.Yu.; Bazarny V.F. in his writings considers the problem of prevention of deviations in the development of students and the formation of a reflex of a low bowed head in the process of mastering skills by children. Such scientists and researchers as Degteva G.N., Kudrya, L.I. considered the hygienic assessment of furniture of preschool institutions and schools. Dzyatkovskaya H. E., Dyachkova M. G. Considered school furniture as a factor of health-saving educational space.

Based on these and many other studies, it is important to emphasize that the functional state at the physiological, psychological and behavioral levels depends on the student's working posture and affects the fatigue and performance of schoolchildren [1].

In this regard, within the framework of this study, work continues to identify an increase in the period of productive working capacity in children engaged in a new model of a school desk that meets the basic ergonomic requirements [2]. Various data were recorded on the basis of surveys and questionnaires of students, teachers and parents.

Survey and questionnaire methods are still an active element included in the analysis of problems that justify project analysis in design. Let's consider the specifics of the questions and the qualitative parameters of the answers contributing to the definition of the main problems:

Table 1 – Pre-project, marketing analysis of consumer requests when designing a school desk, using the parameters of ergonomic research

Consumer	Constructive	Technical
Will the furniture be comfortable and attractive? Is it possible to make the ports individual, not paired, bright in color, to what extent does this meet the rules and standards of training?	What exactly should be the furniture for educational activities and how does it differ from other school furniture	Modern educational processes have changed not only the structure of the lesson, but also introduced new technical factors that contribute to reducing the time spent on mastering educational materials. This is facilitated by furniture equipped with technically advanced parameters
What special qualities should modern school furniture have?	How will the shape of the furniture affect the child's condition, his psyche, physiology?	Is the concept of «smart furniture» relevant in modern times and are there such furniture samples in advanced European schools?
Modern children are not assiduous and hyper-mobile. Will the new furniture contribute to the harmonization of students' mental processes? Bywhatmeanscanthisbeachieved	Is it possible to create a desk whose designs will be able to adapt to the physiological parameters of the student?	Isn't the traditional desk an example of psychological pressure on a modern student? Modern American schools conduct classes sitting in upholstered chairs or even lying on the floor. (Inthelowergrades)

Questions are formed on the basis of the format and objectives of the study and supplemented with questions and thematic blocks important for the study.

The meaning of such questions is to identify a general trend that forms behavioral problems and problems with the violation of bone structures of school-age children.

Doctors, in recent years, have been raising more and more questions about accelerator children, about the increase in various diseases, and, first of all, these are diseases of the musculoskeletal system, as well as other diseases associated with them.

Trends affecting the negative state of health of secondary school students consist in a small change in the designs of school furniture, in the absence of innovative forms that implement the tasks of smart furniture and are able to adapt to individual tasks of the educational environment. Which would certainly affect the reduction of fatigue and working capacity of schoolchildren.

Statistical data on the health indicators of students of secondary schools in Kazakhstan indicate an increase in the incidence of schoolchildren in all classes of diseases. The leading position, in terms of chronic morbidity, belongs to diseases of the musculoskeletal system. This pathology is determined in every third student.

Disorders and diseases of the musculoskeletal system of children lead to further restriction of their vital activity, social insufficiency and, as a consequence, restriction in the choice of profession, contraindications for military service, negative impact on reproductive health, etc. The state and parents have to spend a lot of money on treatment and rehabilitation, physical and mental suffering significantly reduce the quality of human life [3].

There are no articles or scientific studies in Kazakhstan that would analyze innovative technologies in furniture design that affect the change and harmonization of the student's workplace. All the available modes of studying and the influence of the workplace on the functional state of the student are not systematized. That is why we have included an analysis concerning the ergonomic parameters of school furniture affecting the state of the musculoskeletal system as the basis of the practical and experimental research methodology.

Materials and methods

To analyze the sanitary and hygienic condition of secondary schools in Pavlodar, materials of characteristics of furniture compliance with the growth and age characteristics of children in the examined educational institution were used, standard methods of evaluating school and children's furniture in accordance with State Standards and the results of their own research were used. Visual measurements of the working posture of 1st - 9th grade students at the student desk during lessons were carried out.The method of photogrammetry was used to assess the students' posture and determine joint angles. The basis for these studies is the need to monitor human health and vital activity after the introduction of new equipment at enterprises and

educational institutions. Ergonomics makes it possible to conduct analytical studies in the widest range of data and identify average problems when using a particular design product.Based on a wide range of scientific data in the field of school furniture manufacturing, we have developed a classification of problems that became the basis of this study [4].

Ergonomic properties are the properties of things or complexes that appear in the «person-thing-object of activity-environment» system as a result of the implementation of these requirements. The main structural elements of ergonomic research are analysis, synthesis (modeling) and evaluation of the object [1].

Results

The research methods are based on the analysis of human activity, which includes step-by-step interaction with an object or object. Based on this, shortcomings are synthesized and recommendations are made for their accounting. The assessment of human interaction with the design object should reveal the full implementation of ergonomic requirements and adjust the system of interaction «person-object-environment» to create optimal biological parameters that will contribute to improving the quality of work. [5].

Table 2 - Such data is based on the following parameters:

Ergonomic parameters	Type of equipment «chair»	Type of equipment «table»
Convenient use	The chair may have a different seat height	The table changes the angle of the tabletop
Availabilityofuse	No extra effort required	Transformation is simple and accessible
mobility	Easy to move around	Easily moves and transforms
comfort	It is comfortable to sit on a chair for a long time	Anatomically correct forms of furniture are pleasant to a person, there is an effect of relaxation, simplicity of pleasure and comfort
Environmentalfriendliness	Usingnaturalmaterials	
Safety	Additional amenities are being added	Orthopedicinserts

There are classical and ergonomic parameters. Classical ones are used in the study of body proportions, age morphology of characteristics of schoolchildren. Anthropometric directly during the design. Two types of anthropometric features are used in the design process: static and dynamic.

With the student's position unchanged, static signs are determined. They include the dimensions of individual body parts and also overall, i.e. the largest dimensions in different positions and poses of a person.

These dimensions are used when designing things and determining the minimum passages in the premises.

Each block is formed by the designer by specific means and methods.

In practice, developers use the data of the radial table of comfort and maximum permissible values to create comfortable equipment for schoolchildren of various ages.

All factors affecting the human body are taken into account.To calculate such values, somatographic and experimental methods of solving ergonomic problems are used to select the optimal ratios between the proportions of the human figure and the shape, size of the object [6].

If the student's position remains unchanged, statistical signs are determined. They include the dimensions of individual body parts, as well as overall, i.e. the largest, dimensions in different positions and poses of a person.These dimensions are used when designing things, determining the minimum passages.

Dynamic anthropometric features (requirements) are the dimensions measured when a body moves in space. They are characterized by angular and linear movements (rotation angles in x, the angle of rotation of the head, linear measurements of the length of the arm 12 when it is moved up, to the side). These signs are used in determining the angle of rotation of the handles, pedals, determining the visibility zone, etc.

Psychological factors are basic for ergonomics , related primarily to the psychology of activity. The following are relevant: psychological features of children of different school age, psychological features of attention; the role of the psychological climate in the classroom.

The comfort of the stay of junior, middle and senior level children at school is determined by the following data blocks:

1. Hygienic characteristics;
2. Psychophysiological factors;
3. Spatial and anthropometric parameters.

Each block is formed by the designer by specific means and methods. The first one is mainly engineering and technical equipment and measures ensuring the implementation of state stabdards and building regulations.These include noise insulation, ventilation, sufficient daylight and lighting in the evening, the ability to wash your hands, drink water, large recreations realize the problem of active movement during recess.Two

other blocks are related to the age characteristics of students and their abilities. That is why children's educational institutions are divided into medium–standard, special, corrective, etc.

In practice, developers use the data of the radial table of comfort and maximum permissible values to create comfortable equipment for schoolchildren of various ages. At the same time, all factors affecting the human body are taken into account. The comfortable values of each factor are indicated on the inner radius (closest to the person), and the maximum permissible values are indicated on the outer radius, farthest from the person. To calculate such values, somatographic and experimental (mock-up) methods of solving ergonomic problems are used to select the optimal ratios between the proportions of the human figure and the shape, size of the object (Figure 1). In the presented schemes, the necessary values are formed on the basis of which calculations are performed:

– The back touches the back of the chair
– Elbows are on the table
– The feet touch the floor completely
– Back perpendicular to the table
– The position of the knees to the back is 90°
– Viewing angle of books or computer screen no more than 30°

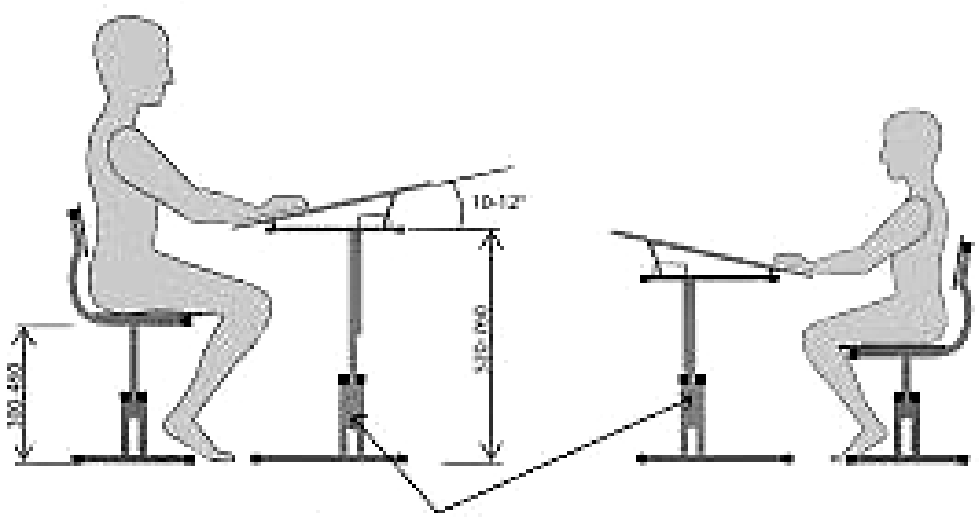

Figure 1 – Chromatographic studies on the basis of which comfortable values of school equipment are taken and calculations of structures are made

Discussion

When calculating the parameters of a student's workplace, it is necessary to use reference bases that correspond to the bases taken when measuring body size

– The selected coordinate system and the corresponding calculation bases;
– Student's working position;
– The magnitude of the scope of working movements;
– Number of workplace elements;
– Visibility Parameters;
– The need to limit the workspace, the possibility of mobility of the workplace element.

A striking example of ergonomic furniture for schoolchildren is a table or desk with an adjustable height and tilt of the table top. These properties of the table are very important for a growing organism, since it can be convenient for a first-grader to work at one height, and after a year – at another.In addition, such a table can be adjusted to the individual characteristics of the child and his personal wishes.

Another common example is chairs with adjustable seat height, as well as with the presence of a headrest and armrests. Such chairs and armchairs allow you to maintain the correct posture and get less tired during educational or gaming activities.

Theergonicity of furniture is not limited to the forms of chairs and tables: it includes all the nuances of creating a comfortable interior.

Ergonomics in furniture is a prerequisite for the rational use of space, as well as the guarantee of excellent physical condition of the body.

Conclusion

On the basis of the studied furniture samples and conducted analytical activities, including questionnaires of students and parents, the following conclusions are made:

The studied standards and comfort factors are listed in a table that allows you to trace the logic of selecting the appropriate parameters in the design and manufacture of various kinds of functional furniture for schoolchildren.

Table 3 – Indicators of qualitative features contributing to the adoption of design decisions in the design of school furniture

№	Types of furniture	Compliance of indicators with the age data of students	Optimal working posture of students	Posture disorders	Data on energy consumption of students using standard and innovative school furniture
1.	table-chair	12,5 %	Maximum fatigue; observed in the 3rd lesson	30,4 %,	Motor activity increases 6 times by the end of the lesson rational working posture - at the 4th lesson, only 5% of students retained
2.	Schooldeskwi tharmrests	86,7 %	87 %	5,4 %.	92% in children, it leads to: a decrease in the response time to a light stimulus, and also stabilizes the heart rate, contractions and blood pressure. The indicator of working capacity in children with: use, ergonomic: student furniture was 0.53 = 0.24 units higher, and anxiety - 1.70 = 0.76 units lower,

The algorithms identified on the basis of the proposed classifications in Table 1 allows us to obtain objective data on the compliance of the working posture with the energy consumption of the body during educational activities.

The arrangement of school classrooms nowadays is strictly controlled by various narmatives and standards, thanks to which the school management can quickly pick up new furniture for recreation, classrooms, locker rooms and other school premises

Such ergonomic studies make it possible to take into account the dimensions of furniture necessary for the correct fit of children of different ages, to justify hygienic requirements for signs, strength, stability, materials, etc. Therefore, the design of furniture items for schools and kindergartens should be carried out not only within the standards but also taking into account the individual physical characteristics of children and allow you to adjust or timely change or adjust to these features the equipment that is used in the educational process

It depends on what kind of furniture designers will design and what data they will rely on will affect the posture and health of future generations.

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Экологиялық және қауіпсіз мектеп жиһазын жобалау кезінде жайлылық пен сапаны қамтамасыз ету әдістері

Физиологиялық, психологиялық және мінез-құлық деңгейлеріндегі функционалды жағдай оқушының жұмыс жағдайына байланысты және оқушылардың шаршауы мен жұмысына әсер етеді. Мектеп жиһазының әр жаңа дамуы бірнеше сынақ циклдарынан өтеді. Осы циклдердің ешқайсысы жабдықтың жайлылығы мен қауіпсіздігінің түпкілікті нұсқасын бере алмайды. Мектеп жиһазын бағалау бірнеше бағытта жүреді: жасына және басқа физиологиялық параметрлерге сәйкес СНМЕ мен стандарттарға сәйкестік, екіншіден, қазіргі заманғы материалдардың сапасы, беріктігі мен беріктігі, сондай- ақ эстетикалық қажеттіліктерд іқамтамасыз ететін және әртүрлі пәндер бойынша сабақ кезінде балалардың дамуымен түзетілуіне ықпал ететін бірқатар функцияларды қамтамасыз ететін форманың дизайны. Сондықтан осы мақаланың негізгі контексті негізгі эргономикалық талаптарға сәйкес келетін мектеп үстелінің жаңа моделіне қатысатын балалардағы өнімді жұмыс **істеу** қабілеттілігінің артуын анықтау болып табылады.

Осы мақаланың мақсаты – жұмыс орнының эргономикалық параметрлерінің, атап айтқанда жиһаздың оқушылардың физиологиялық, психологиялық және мінез-құлық деңгейлеріне және тірек-қимыл жүйесінің күйіне әсерін гигиеналық бағалау.

Осы зерттеудің ғылыми нәтижелеріне қол жеткізу үшін ақпараттық-аналитикалық, кәсіби-графикалық, эргономикалық әдістер, модельдеу, сауалнама және эксперимент әдістері қолданылды.

Ақпаратты талдау барысында ғылыми зерттеулердің материалы зерттелді және жіктелді, онда оқушылардың жұмыс істеу қабілеттілігін , қызығушылығын, ынтасын және өзін-өзі дамытуға ықпал ететін ерекше техникалық жетістіктерді қамтитын инновациялық технологиялар негізінде жасалған мектеп жиһазының функционалды орындылығын, экологиялық қауіпсіздігін талдау әдістері негізделген. Авторлық класстерлер мен кестелер мектептерге арналған ерекше, сонымен бірге эргономикалық және экологиялық және қауіпсіз жиһаз жасауға ықпал ететін көркем дизайнның әртүрлі принциптерінің сауалнамалары мен типологиясының мәліметтерін ұсынады.

Түйін сөздер: гигиена, экология, қауіпсіз жиһаз, мектеп жиһазы, эргономика, инновациялық технологиялар.

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Методы обеспечения комфорта и качества при проектировании экологической и безопасной школьной мебели

Специфика занятий детей школьного возраста предполагает минимальную физическую активность. Временные рамки пребывания за школьной партой, а затем и за учебным столом дома не решают проблем нарушения структуры позвоничника у младших и средних школьников. В связи с этим в основе данной статьи лежат принципы классификации информации о современных достижениях в области эргономики школьной мебели и методах ее проектирования. Большинство образцов современной мебели, несмотря на применение инновационных материалов, включенных в конструкции мебели, не решают проблемы комфортности и безопасности школьного оборудования. Оценка школьной мебели проходит по нескольким направлениям: 1) соответствие СНИПам и стандартам, возрастыми и другими физиологическими параметрами; 2) качество, долговечность и прочность современных материалов; 3) конструкция формы, которая будет обеспечивать эстетические потребности и предусматривать ряд функций, способствующих развитию и коррекции детей во время занятий.

Целью данной статьи является оценка эргономических параметров рабочего места школьника и их влияние на физиологическое состояние опорно-двигательного аппарата, а также на изменение или гармонизацию психологического и поведенческого уровня учащихся.

Для достижения научных результатов данного исследования использовались методы информационно-аналитические, профессионально-графические, эргономические методы, метод моделирования, анкетирования и эксперимента.

В результате исследования был изучен и классифицирован материал научных исследований, в которых обосновываются методы анализа функциональной целесообразности, экологической безопасности и констркутивной оправданности школьной мебели, созданной на основании инновационных технологий, которые включают особые технические достижения и способствуют

повышению работоспособности учащихся, заинтересованности, увлеченности и саморазвития. Предложены авторские кластеры и таблицы, в которых представлены роезультаты анкетирования и типологии различных принципов художественного конструирования, способствующих созданию уникальной и в то же время эргономичной, экологической и безопасной мебели для школ.

Ключевые слова: гигиена, экология, безопасная мебель, школьная мебель, эргономика, инновационные технологии.

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