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SOCIAL DIVERSITY AND EQUITY IN UKRAINIAN EDUCATION THROUGH THE PRISM OF PISA 2018 PERFORMANCE OF UKRAINIAN STUDENTS

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Abstract. Education system policies of any country have among their priorities not only improving students' academic performance and reducing the proportion of students who have low levels of reading, mathematics and science literacy, but also creating equity in education that will allow children with different backgrounds and from families with different socio-economic status to get a quality education. Today, different countries often implement quite different strategies to ensure that children have fair access to a quality education. The results of PISA, a well-known international survey on the quality of students' education, make it possible to get an incomplete, but fairly objective picture of the functioning of education systems in different countries and economies and to evaluate their impact on students' performance. In 2018, Ukraine participated for the first time in this study. Ukrainian students have shown average achievement in major areas of PISA. Of course, many factors influence students' performance but the role of Ukraine's school system is still to be explored. This paper provides an analysis of some of the indicators

obtained by PISA 2018 on the segregation of students across schools, that is, the analysis of how evenly (or unevenly) pupils are distributed across schools regardless of their individual characteristics. Ukraine's results are compared with the OECD average, which makes it possible to draw some conclusions about the implementation of the principle of "fairness" in the Ukrainian education system.

Key words: PISA; education; social diversity; equity; student segregation; students' performance; socio-economic status

Анотація. Політика системи освіти будь-якої країни має в числі своїх пріоритетів не тільки підвищення успішності учнів і зниження частки учнів з низьким рівнем читацької, математичної та природничо-наукової грамотності, а й створення рівних умов в освіті, які дозволять дітям з різним походженням і з сімей з різним соціально-економічним статусом отримати якісну освіту. На сьогодні в різних країнах часто реалізуються абсолютно різні стратегії забезпечення дітям справедливого доступу до якісної освіти. Результати PISA, відомого міжнародного дослідження якості освіти учнів, дозволяють отримати неповну, але досить об'єктивну картину функціонування систем освіти в різних країнах та економіках і оцінити їхній вплив на успішність учнів. У 2018 році Україна вперше взяла участь у цьому дослідженні. Українські учні показали середню успішність за основними напрямками PISA. Звичайно, багато факторів впливають на успішність учнів, але роль шкільної системи України ще належить вивчити. У цій роботі представлений аналіз деяких показників, отриманих PISA 2018 по сегрегації учнів по школах, тобто аналіз того, наскільки рівномірно (або нерівномірно) учні розподілені по школах незалежно від їх індивідуальних особливостей. Результати України зіставляються із середніми показниками ОЕСР, що дозволяє зробити деякі висновки про реалізацію принципу "справедливості" в українській системі освіти.

Ключові слова: PISA; освіта; соціальна різноманітність; рівність; сегрегація учнів; успішність учнів; соціально-економічний статус

Introduction.

Analysis of the main strategic documents of the national (The Strategy of Sustainable Development, 2017; On the Sustainable Development Goals of Ukraine, 2019) and supranational (Lokshina, 2019) level shows that one of the central priorities for modern educational policy of countries, including Ukraine, is to ensure equity and equality in citizens' access to quality education, especially secondary one. The topicality of this task is determined by many factors, both common to all countries and specific to each country.

Surveys show that in many countries, governments are largely able to provide these parameters in education (Schleicher, 2018). However, in Ukraine, as S. Oksamytna noted back in 2014, "during the years of independence in the field of education, many phenomena and processes that do not contribute to the equalization of educational opportunities for individuals of different social backgrounds have formed. … There was a deepening of educational polarization as a component of the general socio-economic polarization of society" (Oksamytna, 2014). The authors of the analytical report of the World Bank in 2019 state a similar situation arguing that "inequality in the education system of Ukraine begins at an early stage and limits the potential of students and the system as a whole." In addition,

they emphasize that "the problem is exacerbated by school segregation and poor learning conditions — especially in rural areas" (World Bank Group, 2019).

These conclusions are confirmed by statistical data collected, for example, at the end of students' completion of general secondary education (Kovtunets, 2015; Report, 2016; Report, 2017), as well as PISA international quality assessment data, which collects information on the performance and contextual characteristics of 15-year-olds[1].

In particular, the National Report on the Results of PISA-2018 states that Ukraine is similar to OECD countries[2] in terms of socio-economic inequality in education. Thus, the strength of the relationship between the average level of success of Ukrainian students and the PISA-index of socio-economic status[3], is 14% (OECD countries – 12%), and the average rate of change of the average reading score relative to the change of the unit of socio-economic status index is 45 points (in OECD countries – 37). The chances of overcoming the basic level in all PISA domains (reading, mathematics and science) for most Ukrainian students with low socio-economic status are on average two to three times less than for students with high socio-economic status (the same figures are for OECD countries).

Both the PISA report and the above-mentioned studies give a general characteristic of the impact of students' socio-economic status in Ukraine on their performance, emphasizing that there is a difference between the opportunities and success of students from wealthy and poor families, from urban and rural areas, from ordinary schools and schools with advanced programs (lyceums, gymnasiums, colleges) and technical/ vocational schools, etc. However, the issue of connection between equal distribution of students in educational institutions by socio-economic status and level of academic success is not studied. Therefore, the question of whether there is a concentration of certain types of students in Ukraine (by level of performance and socio-economic status) in different educational institutions and whether the distribution of students by these characteristics in educational institutions differs from the distribution at the national level remains unanswered; although to a large extent, the answers to these questions can explain something about equality and equity in Ukrainian education.

The aim of the study.

The analysis of PISA results showed a high level of dependence of Ukrainian students' performance on their socio-economic status. The data suggest that segregation and unequal access to education in Ukraine are due to socio-economic factors and are quite high compared to other countries. On the other hand, we can assume that the cause of inequality in the educational system of Ukraine at the level of basic education may be academic segregation, i.e. inequality in the distribution of students by their performance in educational institutions. Therefore, the aim of the study, mainly based on PISA data, is to determine what factor influences the distribution of Ukrainian students among educational institutions: their socio-economic status or their academic performance.

Research Methods, Models and Tools.

The article is based both on the results of our analysis of PISA data and partial use of

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[1] Note. In 2018, Ukraine participated in this international program for the first time.

[2] OECD countries are an organization of high-income developed countries that share common ideas and adhere to the principles of a market economy and democratic pluralism.

[3] Socio-economic status is a broad concept that summarises many different aspects of a student, school or school system. In PISA, a student's socio-economic status is estimated by the PISA index of economic, social and cultural status (ESCS), which is derived from several variables related to students' family background: parents' education, parents' occupations, a number of home possessions that can be taken as proxies for material wealth, and the number of books and other educational resources available in the home. The PISA index of economic, social and cultural status is a composite score derived from these indicators via Principal Component Analysis (PCA). It is constructed to be internationally comparable.

OECD analytical reports on the PISA results. The problem of student segregation at the international level has been investigated based on OECD reports (OECD, 2019(a); OECD, 2019(b)).

PISA-2018 data were used to analyze the performance results of Ukrainian students (https://www.oecd.org/pisa/data/2018database/). The calculation of the basic statistics and the determination of the statistical relationships were carried out according to the relevant PISA results, the Student Questionnaire (https://www.oecd.org/pisa/data/2018 database/CY7_201710_QST_MS_STQ_NoNotes_final.pdf), and the School Questionnaire (https://www.oecd.org/pisa/data/2018database/CY7_201710_QST_MS_SCQ_NoNotes_ final.pdf). The methods of frequency analysis, the standard deviation and the standard error of the mean were used in the process. All calculations were performed using R statistical software including **intsvy**, an R package for working with international assessment data (https://cran.r-project.org/web/packages/intsvy/intsvy.pdf) using PISA data analysis technologies. The MS Excel package was also used in the process of calculating and presenting the results. To analyze school segregation in Ukrainian schools, various indices were used, which are described in described in (OECD, 2017; OECD, 2019(b). Annex A). The main purpose of these indices is to determine how evenly (or unevenly) students are distributed across schools depending on their socio-economic status or academic performance.

So different indices are used to estimate the level of non-uniformity, such as the *Dissimilarity index*, the *Isolation index*, and the *No-diversity index*. All indices range from zero (0) to one (1), where zero indicates no student segregation in schools and one indicates complete segregation of students. When estimating segregation, it is necessary to analyze all the indices together, as they reflect the different sides of the stratification of students by schools and help to make a more thorough analysis.

The *Dissimilarity index* shows whether the distribution of students in schools differs from the overall distribution of students across the country. This index is related to the proportions of students of the two groups who have to be displaced in order to obtain an identical distribution across all schools. This index can be computed using the classic formula:

$$D = \frac{1}{2} \sum_{j=1}^{J} \left| \frac{n_j^a}{N^a} - \frac{n_j^b}{N^b} \right|$$

where n_j^a stands for the number of students of type a in school j; n_j^b stands for the number of students of type b in school j; N^a stands for the total number of students of type a in the country (in all schools sampled for research); N^b stands for the total number of students of type b in the country (in all schools sampled for research).

To calculate the PISA *Dissimilarity index* (proposed in PISA 2015) the following formula was used:

$$CC = \sum_{j=1}^{J} \frac{n_j}{N} \left| \frac{n_j^{disadv}}{N^{disadv}} - \frac{N^{disadv}}{N} \right|$$

where n_j stands for the number of students in school j; n_j^{disadv} stands for the number of disadvantaged students in school j; N^{disadv} stands for the number of disadvantaged students in the country (in all schools sampled for research); N stands for the number of students in the country (in all schools sampled for research).

Another index that measures the probability that an average student from a group (e.g, of low socioeconomic status) will be in contact at school with members of another group (of high socioeconomic status) is called the *Exposure* or *Interaction indicator*. Formally, it can be written as:

$$E = \sum_{j=1}^{J} \frac{n_j^a}{N^a} \cdot \frac{n_j^b}{n_j}$$

where n_j^a stands for the number of students of type a in school j; n_j^b stands for the number of students of type b in school j; N^a stands for the total number of students of type a in all schools sampled for the research in the country; n_j stands for the total number of students in this school j.

The value of this index shows what proportion of students of type a will interact with students of type b. This index is not symmetric: the proportion of students in the group a who can interact with students in the group b may be greater than the proportion of students in the group b who will interact with students in the group a. The value of the *E-index* decreases with the level of segregation of students between the two groups in schools. However, to analyze segregation of students by the PISA performance results is better to use a normalized *E-index* form, namely the *Isolation index* (used in PISA 2015 and PISA 2018), which is calculated by the following formula (OECD, 2019(a); OECD, 2019(b), Annex A):

$$NE(a,b) = 1 - \frac{\sum_{j=1}^{J} \frac{n_j^a}{N^a} \cdot \frac{n_j^b}{n_j}}{\frac{N^b}{N^b + N^a}}$$

where n_j^a stands for the number of students of type a in school j; n_j^b stands for the number of students of type b in school j; N^a stands for the total number of students of type a in all schools sampled for the research in the country; n_j stands for the total number of students in this school j.

One more important index, which reflects no-diversity of students by socio-economic status in schools, is the no-diversity index that is calculated by the formula:

$$H = \sum_{j=1}^{J} \frac{n_j}{N} \frac{h(q) - h(q_j)}{h(q)}$$

where $h(q) = -\sum_{k=1}^{4} q^k \cdot \ln(q^k)$ stands for the entropy (diversity) index that measures a distribution of several groups simultaneously; $q^k = (q^1, q^2, q^3, q^4)$ is the proportion of the groups of he students, in this case, this distribution is carried out by quartile values of the index of socio-economic status, тобто q^k refers to the proportion of 25% students who have the lowest (q^1), average (q^2, q^3) and the highest (q^4) indices of socio-economic status; n_j stands for the number of students in school j; N stands for the total number of students in the country (in all schools sampled for the research).

Results.

Equity in education is one of the most important factors that influence the level of education of the country as a whole and its students, who will build their country in the future. Thus, according to the data of the Programme for International Student Assessment (PISA), country-wide school-choice policies that parents take into account can have significant repercussions for student sorting by both their abilities and socio-economic status. Equity in education is inextricably linked to student achievement. When education

is fair, all children can benefit from learning and find a place in the labor market in the future, but when this principle is violated, it can have negative effects that will directly affect society.

Too often, parents choose the type of school for their child to attend not according to the child's specific needs but according to their capabilities. The type of school often reflects the social status of the neigbourhood where this school is located and results in segregation of children based on family income and living conditions. Social stratification can also be linked to parents who are better informed about schools that might select children based on academic ability by offering a "unique" parent-funded student education program (OECD, 2019(a)). The socio-economic status of a school is often determined by the availability of certain "resources" that are relevant to students' learning, such as the quality and number of teachers, the availability of educational and methodological support (the quality and quantity of computer and multimedia equipment, a swimming pool at school, unique sports equipment, etc.). All these factors lead to social stratification of students and affect their performance.

Social (by a child's socio-economic status) and *academic* (by a child's abilities) segregation of schools takes place in almost all countries, but in most countries, schools are more often differentiated by the academic status of students than by the socio-economic one. The adopted parental school-choice policy can both positively and negatively affect student achievement. On the one hand, free school choice increases competition between schools, but on the other hand, according to PISA data (OECD, 2019(a)), there is no strong link between school competition and student achievement. If schools have an opportunity to select the highest achievers – "cream skim" the best students – it is often difficult to track the efficiency of such schools, i.e. to evaluate the so-called "added value". At the same time, a 'rigid' residence-based school assignment may adversely affect social diversity in schools, especially in urban areas where segregation of students by their socio-economic status exists. On the other hand, free choice of school by parents can also increase the segregation of students, based on socio-economic status, due to various co-payments, charitable contributions that parents are prepared to pay, being confident in the prospect of a good education. It can also result in academic segregation of students. In any case, student sorting, based on socio-economic status or academic ability, may adversely affect the efficiency of school functioning and equity in education.

School-choice policies vary from country to country (including OECD countries). Most school systems promote the possibility for parents to freely choose a school for their children, but for many reasons not all parents can make that choice. This may be both due to parents' inability to provide their child with education at a better school (for example, because the school is located in a different area and they have to spend time and money on transport, or because there are many additional paid after-school activities, etc.), and competitive advantages of schools.

As PISA results show, school efficiency is better achieved through the selection of students with better abilities (high achievers). It creates competition between schools. However, in Ukraine and in most other countries, such competition can mainly be driven by population density. For instance, urban schools are more likely to compete with each other than with rural schools. When asked by the PISA 2018 School Questionnaire, "Which

of the following best describes the options available to students in your area?" with the multiple-choice "1. We have several other schools (two or more) competing with us for students"; «2. Next to us is another school that competes with us for students"; «3. There are no other schools near us that compete with us for students", the principals of most urban schools from major cities of Ukraine chose the first answer, while the principals of rural or small-town schools chose the third one (Figure 1).

Which of the following statements best describes the schooling available to students in your location?
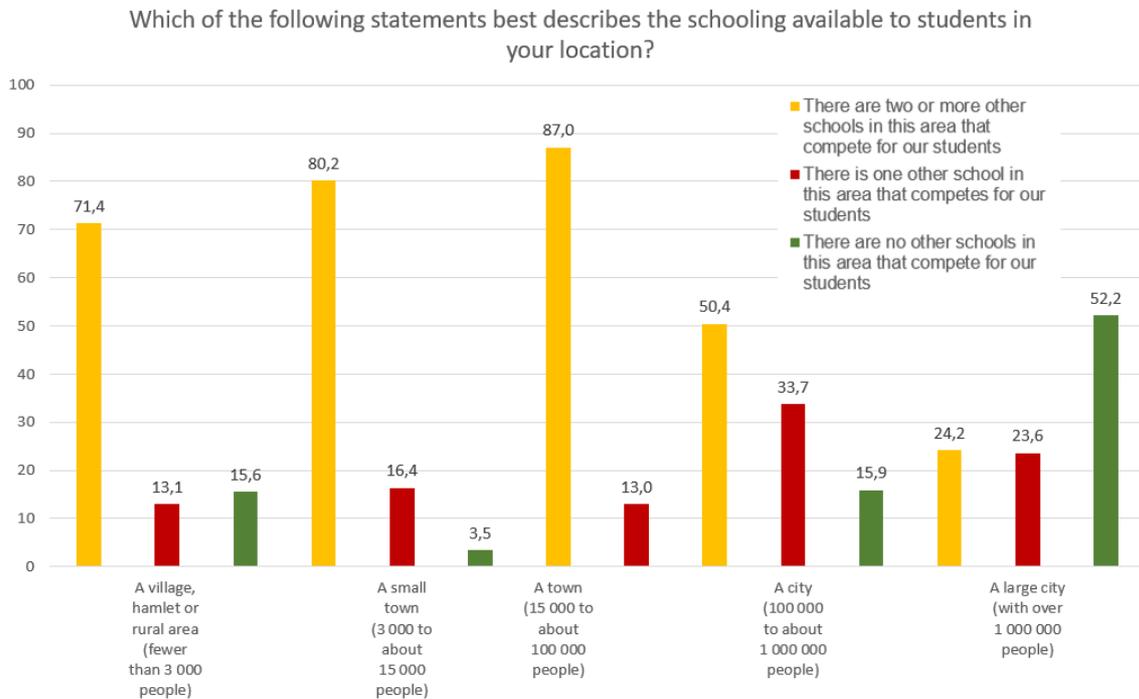
Figure 1. Percentage of schooling options available to students, based on school location

When asked about factors that are taken into account for admission, school principals of schools in Ukraine most often reported that the residence in the respective area and students' academic achievements (including the results of entrance tests) are always considered (Figure 2).

How often are the following factors considered when students are admitted to your school?
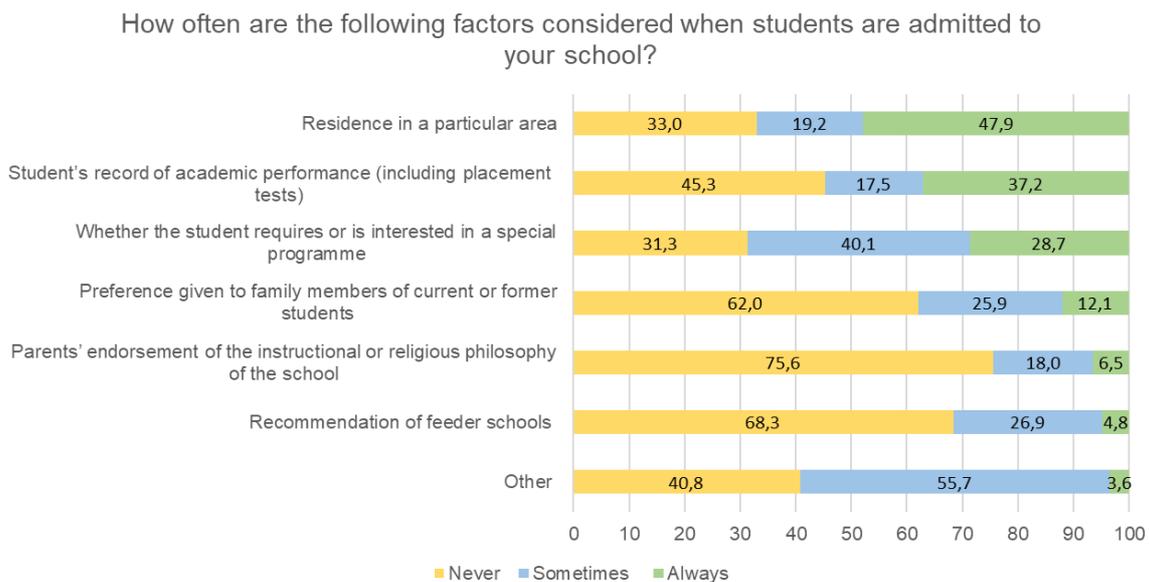
Figure 2. Percentage of responses about factors considered for school admissions

The school choice may also be based on school education programs. Moreover, in Ukraine, students' prior academic performance is more often considered for admission to lyceums, high schools of general secondary education with extensive learning of some subjects, specialized schools and vocational schools than to other types of educational institutions (Figure 3).

How often are the student's record of academic performance (including placement tests) considered when students are admitted to your school?
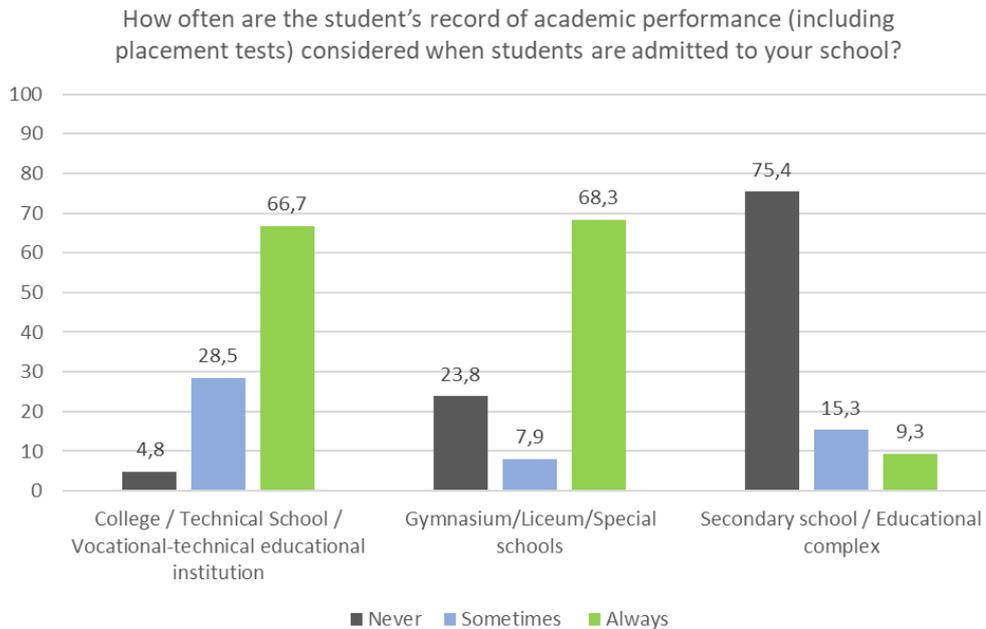
Figure 3. Percentage of responses about the importance of students' academic performance (including placement tests) for school admission, by type of school

Students' PISA proficiency scores in reading are statistically different from the decisions that school leaders make when admitting students: the average scores of students enrolled based on previous academic achievements are higher than those of students who were admitted to schools where principals reported they never or not often take this factor into account (Figure 4). The difference is the same for different types of schools, and for schools located in different types of areas. The performance scores of both students enrolled by the place of residence and students whose admission didn't depend on the latter does not differ on average (Figure 5). In general, the average PISA reading scores of students enrolled by previous academic achievements are higher than the average scores of those enrolled by place of residence.

How often are the student's record of academic performance (including placement tests) considered when students are admitted to your school?
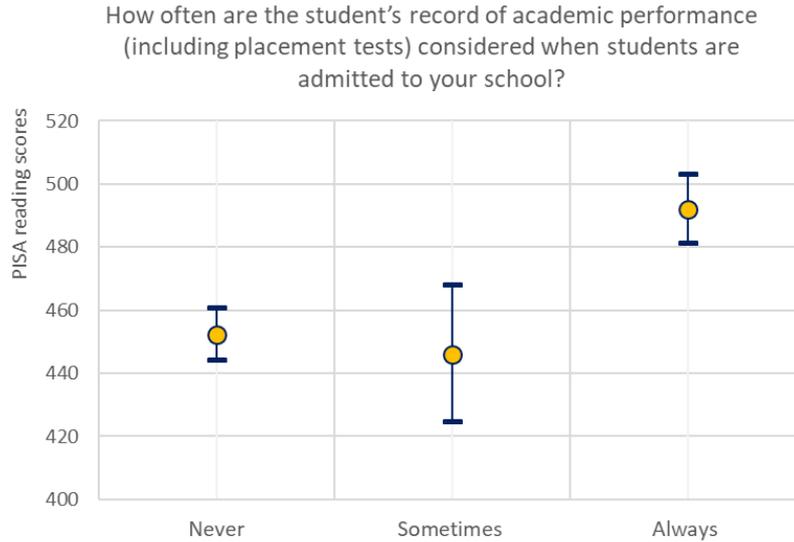
Figure 4. PISA reading scores depending on how often students' previous academic performance (including placement tests) is considered for school admissions

How often are the students' residence in a particular area considered when students are admitted to your school?
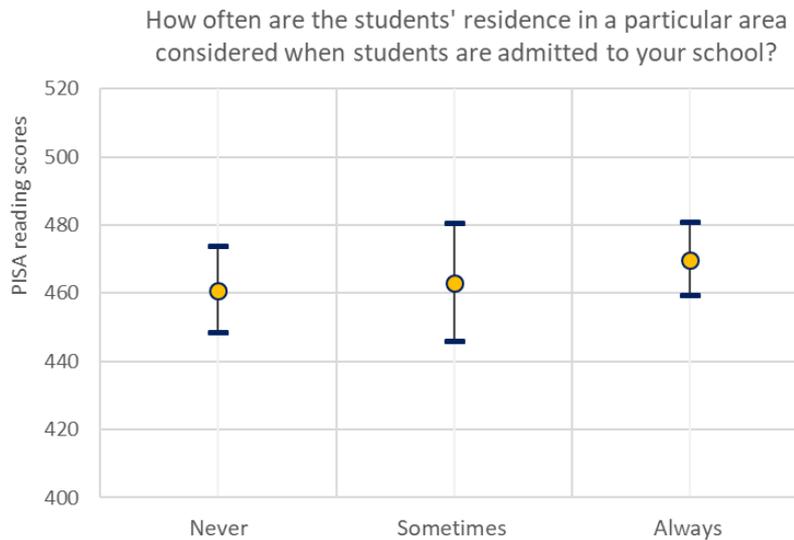
Figure 5. PISA reading scores depending on how often school admission is based on students' residence

The analysis of school principals' reports shows that academic factor is to some extend a factor. The enrollment of students by place of residence does not result in many advantages in academic achievements, which may indicate equity in the school system of Ukraine. However, student segregation is a complex concept that cannot be judged solely on the basis of the frequency distribution of school leaders' reports regarding student enrollment rules, by one of the indicators or an index that reflects student stratification. Therefore, for Ukraine, we calculated the values of the main indices, which are described in the section "Research Methods, models and tools", and these values are compared with similar values for OECD countries.

For Ukraine, the *CC Dissimilarity index* by students' socio-economic status is 0,25, and by the low score reading proficiency in PISA is 0,26. These values correlate well with other indicators that can be obtained using the multilevel regression model (Multilevel Modeling Tutorial, 2015), used in PISA 2018 (OECD, 2019(b)). According to the findings, the socio-

economic status determines the stratification of students across schools to only 27% (estimated on the basis of the indicator (OECD, 2019(b), Ch.4), which is computed according to a two-level regression model with defined levels – levels of students and schools). The indicator includes components of variance/dispersion (within and between schools and is called the inclusion index). Segregation by reading performance rate is 33%. These values indicate that schools affect the socio-economic and academic stratification of students only by one-third (the country's school system), while students' performance still depends on individual characteristics and other factors by about 70%. OECD indicators are similar: about 70% of variation in reading performance and 76% of variation in socio-economic status index is found within schools, and not between schools (OECD, 2019(b), Ch.4).

The Isolation index was calculated for different groups of students, for example, the isolation indices of low performing *N (lowperf, all)* students (25% of students with the lowest PISA reading scores) in relation to all other students in schools, high performing *N (highperf, all)* students (25% of students with the highest PISA reading scores) in relation to all other students in schools. Important indicators are also the isolation indices, which reflect the probability of interaction of students in schoos with students with low *N (lowescs, all)* and high *N (highescs, all)* socio-economic status (25% of students with low or high socio-economic status relatively to all others students). We calculated separately an isolation index that shows how academic segregation is determined by socioeconomic status *N (hihperf, disad)* (25% of students with low socioeconomic status in relation to 25% of students with the best PISA reading scores). If the index value is about 0,5, there is no segregation of students, if it is equal to about 1, then we can talk about complete segregation. The values of these indices are shown in Table 1 for Ukraine and OECD countries.

Table 1

The isolation indices for Ukraine and OECD countries

Countries	$N(lowperf, all)$	$N(highperf, all)$	$N(lowescs, all)$	$N(highescs, all)$	$N(highperf, disad)$
Ukraine	0,24	0,19	0,19	0,19	0,68
OECD countries	0,22	0,21	0,17	0,19	0,67

According to Table 1, in Ukraine, the values of the isolation indices of students with low academic achievements and low socio-economic status are somewhat higher than in OECD countries, but generally quite close to the latter. In most countries, schools have a higher concentration of low-achievers than high-achievers.

Anxiety can be caused by the value of index *N (highperf, disad)* because it means that a typical socio-economically disadvantaged student has only one chance out of six to get to a school where students with high reading scores study. If the distribution were more even, this would be equal to one chance up to four, meaning that both populations would be randomly mixed in schools. This figure correlates strongly with the proportion of 'resilient' students[4]. In Ukraine, at national level, about 12% of 'resilient' students are in reading, 12% – in mathematics, 13% – in sciences, which is even higher than in OECD countries (11% – in reading, mathematics and science) (Mazorchuk, 2019). These data also confirm

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[4] Resilient students in PISA are those who come from disadvantaged backgrounds, for instance, come from families with low socio-economic status, have negative academic or social experience, in comparison with other students of their country, yet exhibit high levels of school success according to international standards.

that in general in Ukraine, as well as on average in OECD countries, academic segregation of students is more common, which indicates a fairly high level of fairness in access to education for students with different socio-economic status.

For Ukraine, the No-diversity index, that measures diversity by socio-economic status, is equal to 0.14, i.e. among educational institutions, the distribution of students by socio-economic status is close to the distribution across the country. The same value of this index is for OECD countries. The low value of this indicator reflects the principle of social justice in schools that contributes to a better level of student performance.

Conclusions.

Thus, by analyzing values of frequency distributions of school principals' reports, indicators and indices that measure different aspects of students' distribution in schools, we can conclude that in Ukraine there is academic segregation of students in schools. Despite the statistically significant difference between the performance of students with different levels of socio-economic status, the impact of the current system of school selection in Ukraine does not increase inequality and segregation by socio-economic status among students. In educational institutions, there is only segregation of students by academic abilities. At the same time, most Ukrainian educational institutions have more students with a low level of performance than with a high one.

Students with low and high socio-economic status are evenly distributed among educational institutions, which confirms the rightness of educational policy pursued in Ukraine. However, the chances of students with low socio-economic status (25% of students with the lowest socio-economic index values) to get the highest scores (25% of the most successful PISA students) are 5-6 times lower than those of students with the highest socio-economic status (25% of students with the highest values of the socio-economic index). These figures are very close to those of the OECD countries, i.e. they are not high. Therefore, it is necessary to focus on reducing the gap between students with different levels of socio-economic status, studying the experience of leading countries, but to make informed decisions without violating the system that exists today.

The study of segregation indicators for different types of educational institutions located in different areas and the formation of strategies to improve the situation of equality and equity in these educational institutions has its perspective. At the same time, we should remember that students' performance is influenced not only by the state's school-choice policies. Their performance depends on many factors. However, focusing on students with low PISA scores (in reading, math, and science) and low socio-economic status indicators, and helping those students overcome obstacles to academic achievements, should be priority areas policies of the educational system of the country. Adhering to certain rules for students' admission to schools, a consistent strategy to ensure equal access to education for students regardless of their place of residence and socio-economic status, equal provision of schools with financial, professional and educational resources will contribute to fairness in education and improve children's performance results.

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