

Differences in General Education in Vocational and High Schools:

Characteristics of Teachers and Teaching Practices in Mathematics

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Abstract. Every year, more and more middle school graduates opt for vocational high schools. They are normally less academically successful students from lower economic and cultural backgrounds.

Still, the vocational education system must provide the chance to have a quality high school education to anyone who follows this track after the ninth grade. The article uses findings of the Trajectories in Education and Careers longitudinal study to compare the key conditions of obtaining a mathematics education in high schools, i. e. the professional and demographic characteristics of vocational and academic high school teachers and their teaching practices. The comparison reveals an inequality in students' access to educational resources depending on the chosen trajectory. The differences revealed are related to the institutional characteristics of the two tracks and make it possible to say that those tracks offer high school education of different types.

Keywords: educational inequality, education quality, vocational education, academic high school, teaching mathematics, teachers, teaching practices.

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Secondary education in Russia can be obtained in institutions of two types: those of general education (10th–11th grades of secondary school) and those of vocational education (vocational or trade schools). In the latter case, general education (in a somewhat modified form) is combined with vocational training.

The last 15 years have seen a redistribution in the flows of middle school graduates choosing between the two educational trajec-

tories after the ninth grade. Between 2000 and 2015, the academic high school enrollment rate dropped from 1,422,400 (66.8 percent of all middle school graduates) to 638,300 (54.9 percent). The outflow of students from academic high schools began earlier and was more rapid in rural localities. Only 45.2 percent of rural school students proceeded to the 10th grade in the 2015/16 academic year [National Research University Higher School of Economics 2010; 2012; 2014; 2016].

As a consequence, vocational and trade schools enrolled more and more middle school graduates from year to year—263,800 in 2000, 313,200 in 2005, and 474,400 in 2016—raising their proportion in the total population of vocational students from 38.6 to 65.9 percent in 12 years. The proportion of vocational students in secondary education thus increased from 35.9 percent in 1990 to 49.2 percent in 2016 [Ibid]. The number of students obtaining secondary education in vocational institutions is now nearly equal to that of students in academic high schools.

In order to assess the consequences of such student redistribution, it is necessary to compare the outcomes of secondary education obtained in academic and vocational high schools. No standardized tests are conducted within vocational education, so probably the only opportunity for such comparison is provided by the Program for International Student Assessment (PISA)¹. The 2015 PISA results reveal a considerable gap in the mathematical literacy of 15-year-old academic high school students (526 scores) and their peers from vocational schools (478 scores)², which corresponds to about 1.6 years of learning³.

These differences have economic effects, too. People who did not acquire a required set of knowledge and general competencies in high school will most likely have to choose from unskilled and low-paying jobs, which makes them extremely vulnerable in the context of rapid socioeconomic and technological development. The lack of social and cognitive skills necessary to live in a contemporary society disqualifies them as workers, reducing their opportunities for professional and

¹ <http://www.oecd.org/pisa/>

² One should be careful when making inferences about the literacy of students in academic and vocational high schools on the basis of PISA results due to some sampling peculiarities. Notably, the data represents 15-year-olds, not students of vocational or academic high schools. Thus, the 2015 Russian sample included 5,268 ninth-graders (87 percent of the sample), 581 academic high school students (9 percent) and 187 vocational school students (4 percent). With these limitations in mind, we believe, however, that the data specified should be largely indicative of the general tendency of vocational school students scoring lower in general subjects.

³ The difference of one year of learning is normally defined as one-quarter to one-third of a standard deviation, or about 30 scores [Woessmann 2016].

career growth [Cedefop 2016a; 2016b]. As the percentage of the college-educated population is growing, those who have not obtained a quality general education will feel even worse in the labor market, which is another factor aggravating social inequality [Lyubumov 2008].

The gap in mathematical literacy unveiled by the PISA is largely conditioned by the differences between students proceeding to academic high school after the 9th grade and those outflowing to vocational education institutions. Russian research findings demonstrate that ninth-graders choosing between the academic and vocational tracks differ in the level of educational achievement and socioeconomic backgrounds, which indicates inequality of educational opportunity [Aleksandrov, Tenisheva, Savelyeva 2015; Bessudnov, Malik 2016; Konstantinovskiy 2010]. Vocational and trade schools are usually chosen by average-performing students. The socio-professional status of their parents varies, being anywhere from skilled workers to highly skilled professionals. Parents and students form this social group regard vocational education as a relatively safe way of improving the family's status, as vocational school graduates often progress to institutions of higher education [Aleksandrov, Tenisheva, Savelyeva 2015; Bessudnov, Malik 2016]. The same studies show that more talented and socially advantaged students choose to proceed to high school.

However, characteristics of students and their families are hardly the only factor determining the level of academic performance. Ample research has found that teacher quality has a significant impact on student achievement. Specifically, better performance is observed in classes taught by teachers with some (yet not too many) years of teaching experience [Rockoff 2004; Rivkin, Hanushek, Kain 2005; Clotfelter, Ladd, Vigdor 2006] and Master's degrees [Goldhaber, Brewer 2000; Kukla-Acevedo 2009]. Other effective teachers include professionals with academic degrees in a specific field (e.g. mathematician, as compared to a teacher of mathematics) [Darling-Hammond 2000] or vocational qualifications [Goldhaber, Brewer 1996; Cavalluzzo 2004; Clotfelter, Ladd, Vigdor 2006; Harris, Sass 2011; Goe 2007].

A number of publications indicate a relationship between student achievement and classroom teaching practices, e.g. active learning methods, when students engage in projects and present their results orally or in writing, explain problem solving methods in front of the class [Frome, Lasater, Cooney 2005], work in groups and discuss their findings [Blatchford et al. 2003], etc. Students tend to perform better in math if their teacher demonstrates the relationship between mathematical concepts and everyday phenomena [Schoenfeld, Sloane 2016; Marcoulides, Heck, Papanastasiou 2005; Wenglinsky 2000; 2002]. However, other findings show that this correlation is not that unambiguous [Carnoy et al. 2016]. Successful development of mathematical thinking skills correlates positively with the frequency

of doing math homework [Cooper 1989; Kannapel et al. 2005; Marcoulides, Heck, Papanastasiou 2005], in particular with the frequency of using final exam tests as part of homework assignments [Zakharov, Carnoy, Loyalka 2014].

All the research referred to above deals with teaching in academic high school. Scholarly literature sheds no light on the extent to which education obtained in vocational high schools differs from that provided in academic high schools in Russia. Little is known about how general subjects are taught in vocational and trade schools. It remains an open question as to whether the social inequality observed at the fork of educational tracks after the 9th grade is exacerbated by the differences in access to educational resources within those tracks.

This study aims to describe the differences in the way mathematics is taught in vocational and academic high schools. The focus is placed on the demographic and professional characteristics of math teachers, their teaching techniques, and the inequality of access to educational resources (in the form of teacher qualifications) among students choosing between the academic and vocational tracks.

The article is structured as follows. Section one describes the research data and methods. Section two presents the findings, i. e. the key characteristics of vocational teachers as compared to those of academic high school teachers, the teaching techniques applied in the classroom by academic and vocational high school teachers, and the results of analyzing student access to educational resources in the academic and vocational tracks. The findings are discussed and inferences are made in the conclusion.

1. Data and Analysis Strategy

1.1. Research Data

The empirical basis of the research was provided by the Trajectories in Education and Careers⁴ longitudinal study organized by National Research University Higher School of Economics. This long-term project is unique for Russia. It started with the Trends in International Mathematics and Science Study (TIMSS) in spring 2011. The sample represented Russian school eighth-graders⁵. The same students, now in the 9th grade, took part in the PISA in spring 2012⁶. After the ninth grade, 32 percent of middle school graduates went on to vocational schools (Table 1). Information about teenagers studying in vocational and academic high schools was collected during the subsequent waves of the longitudinal study, in fall 2013 and spring 2014.

In addition to student testing and surveying, the study included a survey of math teachers (from this point on, information will pro-

⁴ <https://trec.hse.ru>

⁵ For more details on the sampling procedure, see <https://trec.hse.ru/sampling>

⁶ That was an addition to the national PISA-2012 sample.

**Table 1. The tracks of students involved in the longitudinal study
Trajectories in Education and Careers**

	Spring 2011	Spring 2012	Spring 2014	
Educational track	8th grade	9th grade	1st year of vocational school	11th (final) grade of academic high school
Number of students surveyed	4,893	4,399	1,348	2,731

vided on algebra teachers⁷) from the educational institutions⁸. Data on 11th-grade teachers was collected in spring 2014, and vocational teachers were surveyed in spring 2015. The surveys involved the schools teaching at least three longitudinal study participants and vocational institutions teaching at least two. The resulting sample consisted of 294 teachers teaching to 2,347 eleventh-graders (86 percent of all the respondents) and 441 teachers teaching to 741 vocational and trade school students (55 percent of the sample). Given the small number of respondents (60) enrolled in skilled worker and public servant training programs, whose teachers were also included in the sample, the analysis only compared the data for students and teachers of the 11th grade of academic high school and those in the vocational education programs for mid-level professionals.

1.2. Variables

The following easily accessible indicators of teachers' professional experience were the focus of analysis: years of service, qualifications, and professional and top scorer awards. We also compared the demographic characteristics of teachers (gender and age) with their levels of cultural capital (number of books at home⁹). Finally, we compared teacher engagement in self-instruction (how often teachers read literature on the theory and methodology of teaching their discipline).

With a view to identifying the peculiarities of the educational pro-

⁷ In most schools, algebra and geometry were taught by the same teacher.

⁸ The survey of academic and vocational high school teachers was organized by the International Laboratory for Education Policy Research, National Research University Higher School of Economics (<https://ioe.hse.ru/lepa/>) as an additional source of data under the longitudinal project Trajectories in Education and Careers.

⁹ According to Pierre Bourdieu's philosophy, books, just like other cultural products, form a type of objectified cultural capital [Bourdieu 2002]. Using other indicators is unproductive. For instance, the level of education (an operand of institutionalized cultural capital) is a poor discriminator since nearly all teachers possess academic degrees.

cess in academic and vocational high schools, we first of all evaluated how often teachers demonstrate the relationship between the material and other fields of study as well as real-life situations and human activities. The teachers were asked how often their students used the mathematical language to describe everyday life and how often they solved standard problems. Besides, the teachers answered questions about using the teaching techniques designed to increase children's involvement in learning, i. e. how often students were assigned long-term (at least week-long) projects aimed at answering a research question, how often they worked in small groups to find a solution together, etc. The teachers were also asked how often they applied differentiated instruction depending on students' abilities. Finally, some questions bore upon widespread schooling practices: how often students were assigned homework, how often they used USE (Unified State Exam) tests while working in the classroom, etc.

The analysis made allowance for the characteristics of academic and vocational high school students. Mother's education (whether or not the mother has a college degree) and the index of family income¹⁰ were used as indicators of cultural and economic capital. Both variables were obtained from the TIMSS-2011 student survey. In addition, student gender and PISA scores in mathematics were taken into account.

1.3. Analysis Methods

Analysis was conducted in three stages, corresponding to the research objectives. The first stage suggested using descriptive statistics to compare the demographic, cultural and professional characteristics of teachers teaching mathematics to academic and vocational high school students. The significance of differences was assessed using parametric and nonparametric criteria: the Student's *t*-test, the Mann–Whitney *U* test, and the Kruskal–Wallis *H* test.

At the second stage, a series of ordinal logistic regressions was used to assess the significance of differences in math teaching practices in academic and vocational high schools. The frequency of relevant teaching practices was the dependent variable, the type of educational institution (academic/vocational high school) being the main predictor. The analysis controlled for student and teacher characteristics.

At the third stage, we compared accessibility of educational resources for eleventh-graders and vocational students using descriptive statistics and an ordinal logistic regression. Teacher qualifications were the dependent variable, and the predictors included social family characteristics, student gender, and learnings outcomes at the end of the 8th and 9th grades.

¹⁰ The index of family income is calculated based on students' answers to the TIMSS survey questions about having specific household goods at home and recoded into an ordinal scale (low, medium and high levels accounting for 30, 40 and 30 percent of the observations, respectively).

Two limitations must be considered when interpreting the results obtained. First, analysis was descriptive at each stage, in accordance with the research objectives, and did not aspire to evaluate the cause-effect relationships. Second, inferences should rather be made about the peculiarities of educational trajectories than about the performance of vocational schools as compared to academic high schools, given the specific qualities of data, which does not represent teachers. What matters here is the learning environments in which the 2012 middle school graduates found themselves.

2. Findings

2.1. The Demographic, Cultural and Professional Characteristics of Math Teachers

Regardless of the educational track—vocational or academic—most academic high school students had female teachers of mathematics (92 and 95 percent, respectively). The differences between the groups are very small and statistically insignificant (the Mann–Whitney *U* test). The average age of math teachers in academic and vocational high schools was 55 and 50 years, respectively. The number of eleventh-graders taught by teachers aged 41–60 is 23 percent higher than that of vocational students (Fig. 1). At the same time, vocational school students were 20 percent more likely to be taught mathematics by younger teachers (aged 25–41). These differences are statistically significant ($p < 0.05$, Student's *t*-test).

Figures 2 and 3 compare the indicators of teachers' professional experience. Much fewer eleventh-graders than vocational students were taught by teachers possessing up to 15 years of teaching experience (11 and 63 percent, respectively). The greatest gap between the two tracks is observed in the proportion of students taught by new teachers who have worked for up to five years (1 and 35 percent) (Fig. 2). This is in line with the above distribution of students by the age of teachers, whose term of service is linearly correlated to their age. The number of students taught by teachers with the lowest (second) qualification category or those with no teaching credentials at all—normally young teachers with the least extensive experience (of 13 years on average)—was 20 percent greater among vocational school students than among academic high school students (Fig. 3). Academic high schools demonstrate a 21-percent higher proportion of students taught by teachers with professional and distinction awards (75.5% as compared to 54.5%) and a 15-percent higher proportion of students taught by professional competition award winners (27.9% as compared to 13%) than institutions of vocational education. Teachers with professional and distinction awards usually have a more extensive teaching experience. The differences in the distribution of academic and vocational high school students among all the indicators of teacher experience are statistically significant ($p < 0.05^{11}$).

¹¹ The Student's *t*-test was used to compare the teachers' age and years of ex-

Fig. 1. The age of math teachers

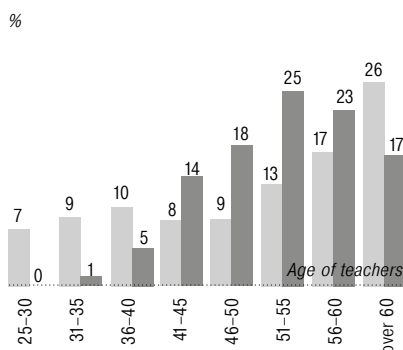


Fig. 2. Teaching experience of math teachers

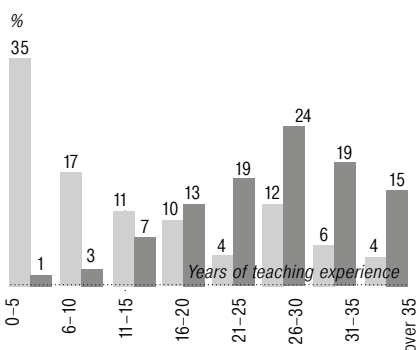


Fig. 3. Qualification categories of math teachers

Students, %

Eleventh-graders
Vocational students

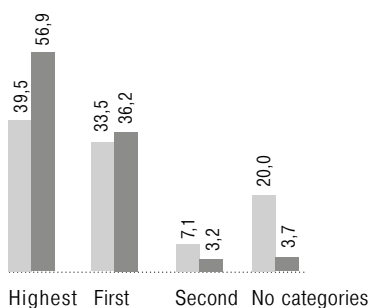


Fig. 4. The number of books in math teachers' homes

Students, %

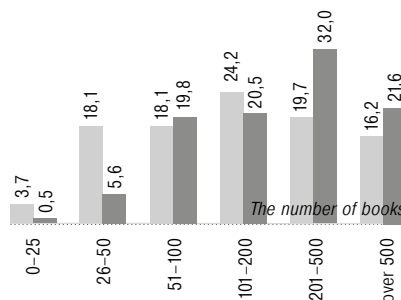


Fig. 5. The frequency of reading mathematical theory books

Students, %

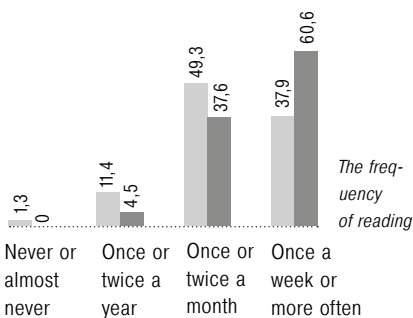
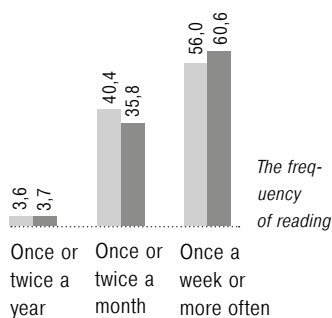


Fig. 6. The frequency of reading books on the methodology of teaching mathematics

Students, %



Figures 4–6 compare the level of cultural capital (the number of books at home) and the level of engagement in self-instruction (the frequency of reading books on the theory and methodology of teaching a specific discipline) among teachers in academic and vocational high schools. Eleventh-graders were more likely to be taught by teachers with greater cultural capital: 54 percent of academic high school students were taught by teachers whose home libraries consisted of 200 books or more, as compared to only 36 percent in vocational schools. Moreover, 22 percent of vocational students were instructed by math teachers with the minimum number of books at home (less than 50), as compared to only six percent in academic high schools (Fig. 4). These differences are statistically significant ($p < 0.05$, the Kruskal–Wallis test).

Academic high school teachers were more likely than vocational school teachers to read specialized literature (Fig. 5, 6). The highest frequency of reading mathematical theory books (once a week or more often) was observed among 61 percent of academic high school teachers and only 38 percent of vocational school teachers. The differences observed are statistically significant ($p < 0.05$, the Kruskal–Wallis test). As for books on the methodology of teaching mathematics, the frequency of reading does not differ that much here. Academic high school teachers were more likely to do it as well, yet the difference was not significant.

Many of the vocational school teachers used to teach academic high school students in the past. The survey results show that such teachers are on average two years older and have an overall teaching experience of on average five years more than their colleagues with no experience of teaching at school. As many as 72.1 percent of the vocational school students were taught mathematics by teachers with academic high school teaching experience¹².

2.2. Classroom Mathematics Teaching Practices Used in Vocational and Academic High Schools

2.2.1. Relationship of Mathematics with Everyday Life and Other Subjects

In order to see how often the elements that students study in math lessons relate to their daily lives and the content of other subjects, we analyzed the teachers' answers to the questions on their engagement

perience, the Kruskal–Wallis H test to compare teacher credentials, and the Mann–Whitney U test to compare the proportions of award winners and distinction holders.

¹² This indicator is considered to be very high, given that 35 percent of vocational students were taught mathematics by teachers with teaching experience of five years or less (see Fig. 2). Otherwise speaking, this data suggests that nearly all the teachers with teaching experience of over three years should have at least some minimal experience of teaching in academic high school. A high indicator like this can also be explained by teacher mobility (see the conclusion section for more details) and the subjective perception of teaching experience by the respondents, who sometimes extend the term to teaching practice they did as students.

Fig. 7. How often teachers demonstrate the relationship of mathematics with other subjects in the classroom

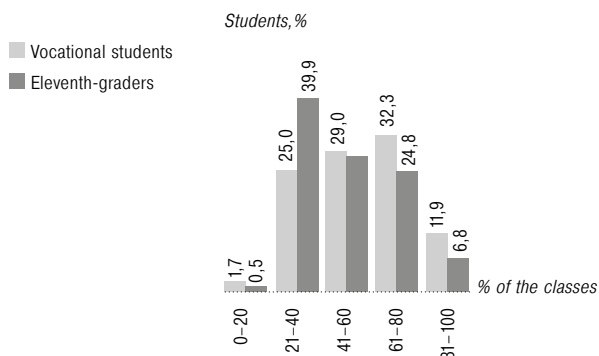
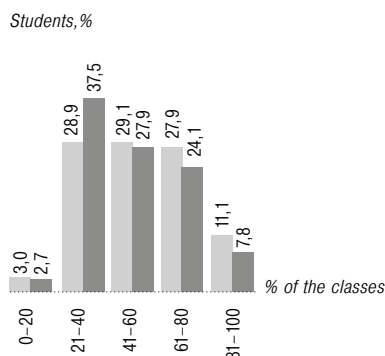


Fig. 8. How often teachers of mathematics demonstrate the relationship of new material with everyday life in the classroom



in the classroom and the frequency of solving specific types of problems in the classroom by students.

In vocational education institutions, teachers were more likely to demonstrate the connections of mathematics with other disciplines (Fig. 7). Seventy-three percent of vocational students and 60 percent of their academic peers had such connections explained to them in over 40 percent of the classes. However, further analysis showed that if allowance is made for teachers' professional experience and cultural capital as well as student characteristics (mother's education for the most part), the differences in the frequency of using such practices in academic and vocational high schools will be statistically insignificant (Supplement 1, Table 1). In other words, it is not the type of educational institution but rather the teacher and student characteristics that explain the differences observed.

Vocational teachers were also slightly more likely to demonstrate how new material was related to students' everyday lives (Fig. 8). This difference in teaching is not too prominent: 68 percent of eleventh-graders and 60 percent of vocational school students obtained such information in over 40 percent of the classes. Just as in the previous case, this difference is determined by student characteristics and becomes statistically insignificant if student achievement in the 9th grade (PISA score in mathematics), family income and mother's education are controlled for (Supplement 1, Table 1).

Eleventh-graders were more likely to describe real-life events and phenomena using the mathematical language: such tasks were performed by 56 percent of academic high school students and only 39 percent of vocational students in over 40 percent of the classes (Fig. 9). If we compare equally-performing middle school graduates with the same sociodemographic characteristics taught by equally experi-

Fig. 9. How often students describe everyday life phenomena using the mathematical language in the classroom

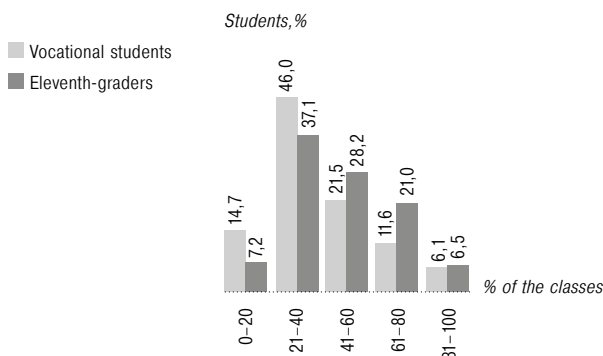
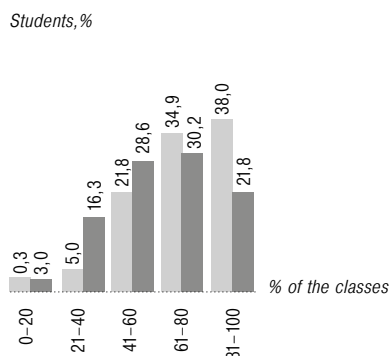


Fig. 10. How often students train to solve standard problems in the classroom

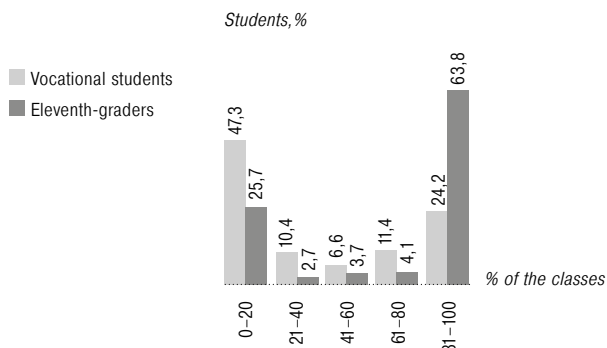
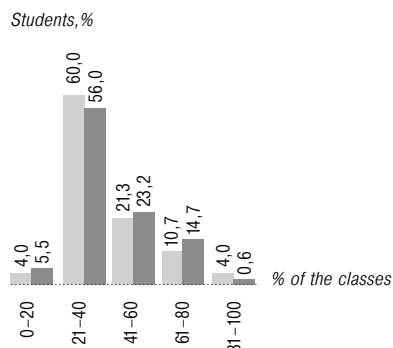
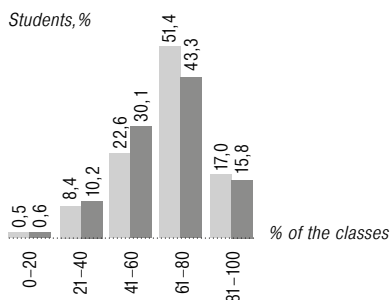


enced math teachers, their chances of solving such tasks in academic high school are 1.5 times higher than in vocational schools (Supplement 1, Table 1). Vocational students solved standard problems in the classroom more often than eleventh-graders (Fig. 10): 73 percent as compared to 52 percent of academic high school students in 61 percent of the classes or more often. Even if the teacher and student characteristics are controlled for, the chances for doing conventional tasks are 1.7 times higher among vocational students than among their academic peers (Supplement 1, Table 1).

2.2.2. Classroom Management

Homework is assigned more often in academic high school: 64 percent of eleventh-graders received homework assignments in nearly every class (81–100 percent of the classes). Only 24 percent of vocational students were given homework as often (Fig. 11). These differences retain statistical significance when controlling for student and teacher characteristics: eleventh-graders' chances of being assigned homework are almost four times higher (Supplement 1, Table 1).

As for practices designed to promote students' engagement in learning, differences are not always observed here. The frequency of working in small groups is nearly the same in both educational tracks (Fig. 12; Supplement 1, Table 1). Vocational students were more likely to be given assignments depending on their abilities (Fig. 13). Sixty-eight percent of vocational students and 59 percent of eleventh-graders performed differentiated tasks in over 60 percent of the classes. Finally, nearly all vocational school students (96.9 percent) were given math assignments in the form of long-term (at least week-long) projects aiming to find a research solution. This practice has been very widespread in schools over recent years, yet it was not ubiquitous at the time of the survey—80.9 percent of eleventh-graders

Fig. 11. How often teachers assign homework in the classroom**Fig. 12. How often students work in small groups in the classroom****Fig. 13. How often teachers apply differentiated instruction in the classroom depending on students' abilities**

in the sample were engaged in such projects. On the whole, if we compare students with the same context characteristics taught by teachers with similar experience and cultural capital, we can see that vocational students are much more likely to often engage in activities that suit their abilities better and to participate in research projects (Supplement 1, Table 1).

Although vocational school graduates are admitted to most colleges without passing the Unified State Exam (in cases where the fields of study match), vocational school teachers still use USE tests in the classroom. However, teachers in the eleventh grade, where the USE is obligatory, pay more attention to USE tests. In more than half of the classes, part B tests were performed by 34.8 percent of academic high school students and part C tests by 26.4 percent, as compared to 8.1 and 10.6 percent of vocational students, respectively (Fig. 14, 15). If student and teacher characteristics are taken into account, we

Fig. 14. The proportion of time devoted to part B USE tests in the classroom

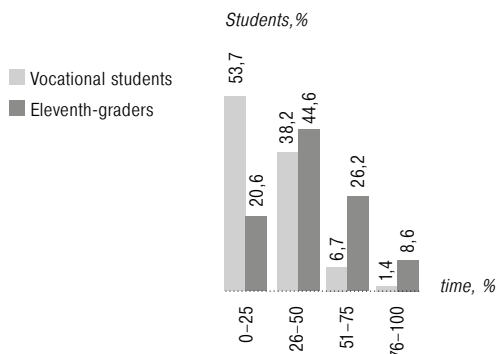
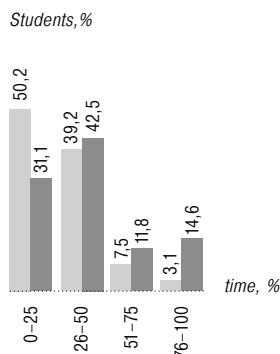


Fig. 15. The proportion of time devoted to part C USE tests in the classroom



can see that academic school students, for instance, are four times more likely to solve part C tests in the classroom than their peers in vocational schools¹³ (Supplement 1, Table 1).

2.3. Access to Educational Resources among Academic and Vocational High School Students

Previous research has shown that the academic achievement of middle school graduates opting for vocational education is much lower than that of their peers progressing to the tenth grade. Where levels of academic achievement are comparable, vocational students tend to have families of lower cultural capital [Aleksandrov, Tenisheva, Saveleyeva 2015; Bessudnov, Malik 2016, Konstantinovskiy 2010]. In spite of such distribution, the student population in both academic and vocational tracks remains heterogeneous in terms of academic achievement and family social characteristics. This study analyzes whether the two tracks provide equal access to educational resources, e. g. in the form of teachers' professional experience, for students from similar family backgrounds.

Students differing in the level of cultural capital and family income are distributed unevenly among teachers with different qualification categories in both academic and vocational high schools (Fig. 16). Both trajectories reveal a principle that could be conventionally referred to as "support for the strong". Students from wealthier families with higher levels of cultural capital are more likely to be taught by better qualified teachers, whichever educational track they choose to follow (Fig. 17). However, further analysis demonstrates that this dif-

¹³ The great difference in the chances of doing part B tests observed when student and teacher characteristics are controlled for can be explained by the fact that those characteristics correlate with both the frequency of doing tasks and the choice of educational trajectory (academic or vocational high school).

Fig. 16. The distribution of students among teachers of different qualification categories depending on whether their mothers have a college degree

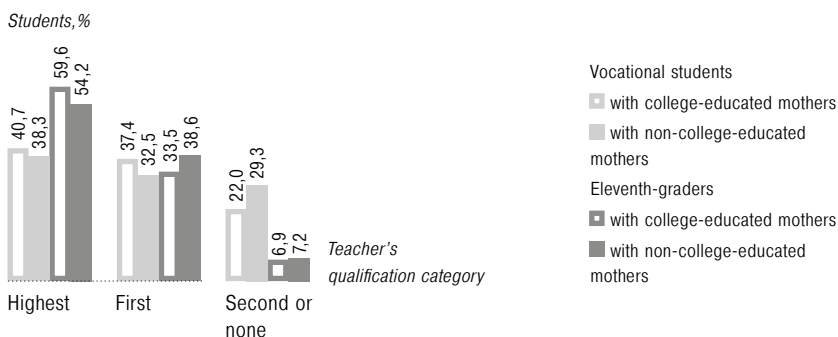
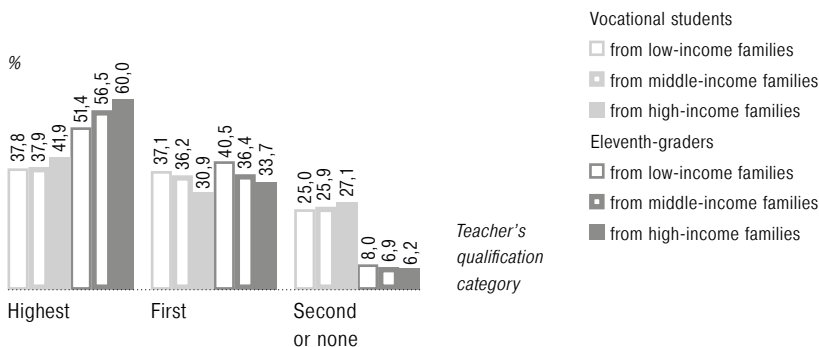


Fig. 17. The distribution of students among teachers of different qualification categories depending on their family income



ferentiation manifests itself more in academic high schools, mostly correlating with family income. The differences observed are statistically insignificant in vocational schools, while eleventh-graders from low-income backgrounds have significantly lower chances of being taught by math teachers of higher qualification categories than their peers from wealthier families, even with equal levels of academic achievement at the end of the 8th or 9th grade. Besides, the odds of being taught by a better qualified teacher are higher for students who demonstrate better learning outcomes in mathematics at the end of middle school, which is true for both educational tracks (Supplement 1, Table 2).

3. Inferences and Discussion

Differences in access to quality education are largely conditioned institutionally. The educational contexts in academic and vocational high schools differ greatly not only in terms of administration and management but also in the educational environment characteristics. The choice of educational track after the 9th grade determines the extent of subsequent access to educational resources, i. e. how qualified the teachers will be and which teaching practices they will use. This raises two questions: (i) what causes the differences between the educational trajectories? and (ii) what are the students' benefits or losses from choosing a specific trajectory?

The longitudinal study participants who went to vocational schools after the 9th grade were much more likely to be taught by math teachers with relatively lower levels of cultural capital and little teaching experience without a high qualification category or professional credentials than their academic high school peers. This situation can be partly explained by differences in teacher pay between academic and vocational high schools. The so-called Putin's May decrees suggested bringing teacher pay in line with the region's average in both academic and vocational high schools, but the rates of teacher salary growth differed greatly between the two types of educational institutions. Whereas teacher salaries in academic high schools had reached the required level by 2014, vocational schools are only expected to reach it in 2018¹⁴. As a result, salaries of math teachers with the same workload could differ between academic and vocational high schools by as much as 15–25 percent during the survey period [Kuzminov, Popova, Yakobson 2017], which inevitably affected the distribution of employees. Young teachers normally have less experience and fewer professional skills, and they are also less involved in professional networks that can provide access to higher-paying jobs [Roshchin 2006]. As a consequence, it was easier for graduates of teacher education colleges to start their careers in vocational education institutions.

At the same time, recent years have seen the number of teacher jobs in vocational high schools growing at the expense of those in academic high schools due to student redistribution. The demographic crisis and the reorganization of the school network in the 2000s caused the number of middle school graduates proceeding to academic high school to reduce by 55.2 percent over a fifteen year period (from 1,422,400 in 2000 to 638,300 in 2015). Vocational and trade schools, on the contrary, kept increasing their middle school graduate enrollment rates (from 313,200 in 2005 to 474,400 in 2016) [National Research University Higher School of Economics 2010; 2012; 2014; 2016]. The result was not only a greater number of jobs for young teachers in vocational education institutions but also an outflow of

¹⁴ Decree of the President of the Russian Federation No. 597 "On National Social Policy Measures" of May 7, 2012: <http://legalacts.ru/doc/ukaz-prezidenta-rf-ot-07052012-n-597/>

teachers from academic to vocational education institutions, which has been documented in this study.

By choosing a specific educational track, students predetermine not only the teacher characteristics they will have to deal with but also the teaching practices that will be applied to them. Vocational students are comparatively less likely to be asked to describe everyday life phenomena using the mathematical language and more likely to solve standard mathematical problems. On the other hand, they are comparatively more likely to receive differentiated instruction depending on their abilities and to work on long-term (at least week-long) research projects. Meanwhile, eleventh-graders are more likely to be given homework and do USE tests in the classroom more often.

Some discrepancies, e. g. in the frequency of applying differentiated learning techniques, are hard to explain. Others may be largely conditioned by the institutional peculiarities of the two tracks (the content of education and the quality assessment methods) and the level of middle school graduates' competencies. In particular, USE tests are more often used in the classroom by academic high school teachers than by their colleagues in vocational schools because all eleventh-graders have to take the USE as a final exam, which is not the case with vocational students. The reason for the difference in the frequency of doing homework may be the same, as eleventh-grade homework assignments are mostly built around preparing for the USE [Zakharov, Carnoy, Loyalka 2014], the outcomes of which determine students' life chances and the results of teacher and school performance assessment.

The findings about practice orientation in teaching mathematics in academic and vocational high schools look somewhat controversial. Unlike in academic high schools, it is recommended to organize secondary education in vocational schools in connection with the future career context. This should be achieved, in particular, by engaging students in project activities and establishing the relationship of what is learned in general subjects with everyday life and career-specific disciplines¹⁵. Project activities are thus an obligatory component of the content of vocational education. At the same time, the relationship of new material with everyday life and other subjects is established in a rather formal way in the classroom—from the teacher's words. In this study, vocational and academic high school students were told, with equal frequency, about this relationship. The fact that teaching mathematics is only formally practice-oriented is also con-

¹⁵ Recommendations on Implementing the High School Education Program in Institutions of Vocational Education Pursuant to the Federal Basic Education Plan and the Guidelines on Developing Education Plans for Vocational Education Institutions of the Russian Federation. Letter of the Ministry of Education and Science of the Russian Federation No. 03–1180 of May 29, 2007: <http://www.garant.ru/products/ipo/prime/doc/6232537/>

firmed by the higher frequency of explaining everyday life phenomena using mathematical language among eleventh-graders.

The differences observed in practice-oriented learning may be related to the level of students' mathematical competencies. Middle school graduates going to vocational schools usually have lower achievement in mathematics [Bessudnov, Malik 2016]. For most of them, learning math is fraught with a lot of difficulty, and applying mathematical relations to solve practical problems requires quite a bit of knowledge of mathematical theory [Tyumeneva, Valdman, Carnoy 2014]. Vocational school teachers thus have to spend much more class time on explaining the basic mathematical concepts and solving standard problems within each topic to ensure that at least the basics are digested. Under such conditions, teaching students to apply mathematical knowledge to solve real-life problems requires more time and effort.

The differences in teachers' engagement in self-instruction may also be determined by the level of student competencies and the external assessment system. Feeling no pressure from the looming USE and working with academically weaker students, vocational school teachers experience a lesser need to look to books on mathematical theory on a regular basis.

Another issue associated with the choice of educational track after the 9th grade has to do with the effects of observed inequality in access to educational resources. To what extent do students win or lose in terms of the quality of secondary education by choosing between vocational school and academic high school? Unfortunately, it is impossible to compare the learning outcome of graduates from academic and vocational high schools directly. The standardized examination testing the knowledge of the secondary education content is only mandatory for eleventh-graders. However, some assumptions can be made based on earlier findings. For example, it has been established that teachers with some teaching experience (yet not too extensive) are more effective than new teachers, the peak of their effectiveness being observed during the first years of teaching [Hattie 2017:166–167]. Other researchers have shown that it makes a lot of difference for low-performing math students to be taught by teachers with qualifications, whereas qualification grades play no great role in regards to high performers [Carnoy et al. 2016]. Vocational schools are more likely to enroll teenagers with low achievement in mathematics who are taught more often by young teachers with minimum experience and no qualifications. Such students can be expected to lose out by choosing the vocational track.

Social inequality in access to educational resources (in the form of teacher' qualifications) and thus probably in the chances for better learning outcomes manifests itself ambivalently. When students—often from families of low cultural capital [Bessudnov, Malik 2016]—choose the vocational track, this very choice reduces their chances

of access to resources. However, students progressing to academic high school do not get better access to educational resources by default. Further distribution of academic high school students among teachers of various qualification grades is determined by the level of family income.

By choosing an educational track after the 9th grade, students choose their future. Both academic and vocational high schools should provide access to quality education, which is hardly possible in a situation of unequal access to educational resources overlapping the social inequality in actually choosing between the two educational tracks.

Supplement 1 Table 1. **How educational processes differ between academic and vocational high schools¹**

Dependent variable	Model 1	Model 2	Model 3
How often teachers demonstrate the relationship of mathematics with other subjects	0.56*** (0.11)	0.54** (0.14)	0.46 (0.23)
How often teachers demonstrate the relationship of new material with everyday life	0.67** (0.13)	0.78 (0.23)	0.63 (0.29)
How often students describe everyday life phenomena using the mathematical language in the classroom	1.90*** (0.41)	1.86*** (0.05)	1.50*** (0.11)
How often students train to solve standard problems in the classroom	0.39*** (0.09)	0.53*** (0.02)	0.59*** (0.02)
How often teachers assign homework	3.69*** (0.86)	3.43*** (0.14)	3.97*** (0.43)
How often students work in small groups in the classroom	1.07 (0.24)	1.15 (0.21)	1.05 (0.26)
How often teachers apply differentiated instruction in the classroom depending on students' abilities	0.43*** (0.09)	0.35*** (0.02)	0.37*** (0.02)
Whether teachers have given project assignments	0.12*** (0.86)	0.11*** (0.14)	0.13*** (0.43)
Proportion of time teachers devote to part B USE tests in the classroom	5.82*** (1.35)	8.64*** (2.56)	10.78*** (1.11)
Proportion of time teachers devote to part C USE tests in the classroom	7.68*** (2.40)	5.38*** (0.20)	4.22*** (0.40)

¹ The table rows present the results of analyzing the relationship between the dependent variable in column 1 and the type of educational institution (0 = vocational school, 1 = academic high school). As the dependent variables had an ordinal scale (1 = 0–20% of the classes; 2 = 21–40% of the classes; 3 = 41–60% of the classes; 4 = 61–80% of the classes; 5 = 81–100% of the classes), an ordinal logistic regression was used to assess the relationship. In the case of project assignments, a logistic regression (binary choice model) was used. Columns 2–4 capture the ratio of chances of academic high school students to those of vocational students for doing tasks of a specific type more often. No covariates were used in model 1. In model 2, analysis controlled for

student characteristics: gender, socioeconomic status, PISA score, and mother's education. Model 3 controlled both student and teacher characteristics, the latter including qualification category, the frequency of reading books on the methodology of teaching the subject, and the number of books at home.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2. The difference in the chances of students from low-income families for being taught by highly-qualified math teachers in academic and vocational high schools¹

Variable	Vocational high school			Eleventh grade of academic high school		
	(1)	(2)	(3)	(4)	(5)	(6)
Low-income family	1.09 (0.20)	1.09 (0.21)	1.30 (0.27)	0.74** (0.10)	0.77* (0.11)	0.76** (0.10)
Middle-income family	1.00 (0.22)	1.02 (0.23)	1.17 (0.29)	0.89 (0.10)	0.87 (0.10)	0.87 (0.10)
College-educated mother	1.25 (0.25)	1.19 (0.24)	1.23 (0.28)	1.16 (0.17)	0.99 (0.13)	1.02 (0.13)
No data on mother's education	1.36 (0.27)	1.39* (0.27)	1.36 (0.27)	0.91 (0.15)	0.93 (0.16)	0.94 (0.16)
Student gender (female)	1.03 (0.20)	1.04 (0.21)	0.99 (0.20)	0.92 (0.09)	1.00 (0.10)	0.98 (0.11)
PISA score (standardized)		1.24** (0.13)			1.57*** (0.16)	
TIMSS score (standardized)			1.40*** (0.16)			1.41*** (0.15)

¹ Teacher's qualification category is the dependent variable. The relationship was assessed using an ordinal logistic regression. "High level" is the reference group for the index of family income, and "no college degree" is the reference group for mother's education. Columns (1) and (4) did not control for previous learning outcomes of students. Columns (2) and (5) controlled for PISA results (9th grade). Columns (3) and (6) controlled for TIMSS results (8th grade).

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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