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HISTORY OF EDUCATION

BOOK REVIEWS AND SURVEY ARTICLES

# To Remain as a Teacher:
## Factors Influencing Attitudes towards Leaving the Teaching Profession

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**Abstract.** The present study examines structural and socio-psychological factors affecting attitudes towards quitting the profession among school teachers. We explore effects of perceived workplace difficulties, employment opportunities, self-efficacy beliefs, and emotional attachment to the teaching profession. The survey was conducted among public secondary school teachers in Saint Petersburg, Russia (N = 730). The regression analysis revealed that self-efficacy beliefs and professional commitment are the strongest predictors for retention, some work-related stress factors contribute to the likelihood of switching profession, while the number of years of teaching experience and work experience outside of teaching have no effect. The results do not support the hypothesis that early-career teachers are more tolerant to switching professions. The implications for retaining teachers in the profession are discussed.
**Keywords:** teachers, employee attitudes, self efficacy, professional commitment, labor turnover

**Introduction**

The decision to choose a teaching career is not necessarily taken once and for life; it can be reversible. Giving up a teaching career and making a transition to another occupation is in many countries of the world most often attested among beginner teachers in the first five years of their school employment [Grissmer, Kirby 1997; Liu, Ramsey 2008]. But more experienced teachers sometimes take the decision to leave the profession, too, and economical considerations may be part of their decision [Baugh, Stone 1982; Harris, Adams 2007].

Attrition of qualified and active young teachers is a process that presumably affected the age structure of the population of school teachers in Post-Soviet Russia. In 2013, Russia participated in the OECD Teaching and Learning International Survey (TALIS). In this survey, the proportion of teachers older than 50 turned out to be

much higher (almost 40%) in Russia than in other participating countries, while at the same time the percentage of very young teachers is twice as high in Russia (4.7% of teachers younger than 25) as in other countries [Pinskaya et al. 2015]. Middle age teachers turned out to be the most diminished cohort in comparison with other countries. The question of whether or not young teachers will stay in the profession becomes essential to preventing the aging of teacher population in this situation and to develop a sustainable teacher recruitment and retention policy. The research of individual and organizational factors influencing the attitudes of teachers toward leaving the profession is required to obtain data necessary for the development of evidence-based policy in this area.

Teacher turnover is a topic of long-standing research interest occasionally supported by published data reporting critically high levels of attrition among teachers (see e. g., Ingersoll 2001). A wide range of institutional, economic, and organizational factors have been studied, that can serve as predictors of teacher turnover at schools. A prominent group of predictors that emerged in this research is a group of socio-psychological factors characterizing the attitudes of teachers toward their work and the profession at large: teachers' job satisfaction, individual and collective self-efficacy, and professional commitment [Ashton, Webb 1986; Goddard, Goddard 2001; Ingersoll 2001; Wang, Hall, Rahimi 2015]. However, most of the research on this topic was performed using data from North America and Europe. We were unable to find similar studies based on Russian data.

Our research is based on a sample of teachers of state secondary schools in Saint-Petersburg. Our goal is to study the interplay between the structural and socio-psychological factors in a teacher's decision to stay in school. We evaluate the significance and relative importance of individual-level predictors (type of education, work experience both within and outside of school), job-related stress factors (conflicts with colleagues, conflicts with administration, difficulties with students etc.), and two important socio-psychological constructs: self-efficacy and commitment to teaching. Policy implications are discussed along with the research results.

**Turnover process models**

The act of quitting a job is generally treated as the final step of a long psychological process for an employee involving job-related attitudes and decisions. The existing models explaining employee turnover are far from reaching any consensus on the details of the process, but agree on a general sequence of stages [Steel, Lounsbury 2009]. The commonly acknowledged path leading to resignation is structured along the lines of ecological reasoning from distal to proximal conditions. Factors external to an individual, such as the job market and organizational or family situation, constitute distal conditions forming the initial stage for the turnover process. The next stages of the pro-

cess are characterized by changes in job attitudes, eventually forming a psychological condition that was recently conceptualized as a state of withdrawal from the job. On the last stages of the process explicit intentions of quitting can be attested followed by eventual resignation [Hom et al. 2012].

In empirical studies intentions of quitting proved to be the most reliable predictor for the actual turnover [Carsten, Spector 1987]. The downside of this predictor is its rather weak explanatory power. The more specific intentions are measured (like, 'quit in December'), the more trivial their predictions become [Hanisch, Hulin, Roznowski 1998]. Thus to explore causes for turnover, concepts pertaining to earlier stages of turnover process models are more useful.

In a classical formulation by March and Simon (1958), two crucial conditions for turnover were given as an individual's perceived ease of movement out of the job and the perceived desirability of such movement. Since then, the attitudinal sphere is commonly seen as a key mediator between distal factors and behavior leading to actual turnover. Empirical studies have identified a substantial list of attitudinal constructs associated with the likelihood of quitting a job: burnout levels, work motivation, job satisfaction, self-efficacy, commitment to the workplace and the profession, and withdrawal cognitions, to name a few [Steel, Ovalle 1984; Griffeth, Hom, Gaertner 2000]. These constructs are usually seen as interrelated and sometimes overlap in terms of survey items used to measure them. The causal path leading from negative attitudes toward work to turnover need not be direct and uniform for all employees. Some theorists advocate a non-linear interpretation for the decision taking process leading to quitting a job [Lee, Mitchell 1994; Steel 2002]. For our work, we find Lee and Mitchell's notion of a *script* to be of most conceptual utility in this domain. A script refers to a pre-defined plan of action that becomes a potential behavioral response whenever some external events disturb the stability of one's attitudes to her job and trigger the turnover process [Lee, Mitchell 1994]. We regard the idea of switching one's occupation for higher pay to be appropriately described as a script in a sense, and close to Lee and Mitchell's. Evaluating attitudes to such a script among respondents is a good way to find the subgroup that is prone to switching professions due to experiencing difficulties.

**Empirical data on teacher turnover**

The causes of teacher attrition is a long-respected topic in educational studies [Guarino, Santibanez, Daley 2006]. In this section, we briefly summarize available data on teacher turnover in general, with a particular focus on individual predictors for teacher attrition.

Public interest in predicting teacher turnover is explained by the high practical importance of the problem. US data published by Ingersoll (2001) showed high rates of yearly loss of teachers by school districts, either to other districts or out of the profession [Ingersoll 2001].

Some other studies have shown that the overall teacher turnover rate actually is not higher [Harris, Adams 2007], or is even lower [Henke, Zahn 2001; Stinebrickner 2002] than in other comparable occupations. Still, much empirical research on teacher turnover has been published since 2000 both inside and outside the US.

At an individual level, turnover rates for teachers are strongly associated with years of teaching experience. In the empirical studies of US teachers, a characteristic U-shaped pattern of teacher attrition emerged. The highest turnover is attested among beginner teachers in their first years of service and among the pre-retirement age group [Grissmer, Kirby 1997; Liu, Ramsey 2008]. The high turnover among beginner teachers is explained mostly in terms of (un)successful adaptation to the profession, often with reference to professional identity formation [Cochran-Smith et al. 2012]. The high turnover in the pre-retirement group is best explained by the high pension-to-salary ratio for US teachers, which makes early retirement attractive [Harris, Adams 2007].

Many of those who left teaching at some point in their career return to the profession several years later. Grissmer et al. (1992) found that during the 1980s, 40% of teacher hires were comprised of teachers returning to the profession. Longitudinal data show that of all the teachers who quit, approximately every third teacher returns to teaching at some point during the next five years. This figure is the same both for teachers who left the work force for child-care and for those who left for other occupations [Stinebrickner 2002].

The wage level in alternative occupations available for teachers is an obvious predictor for turnover. Indeed, in making decisions about quitting, teachers were found to be at least as responsive as other workers to wage differentials between teaching and other occupations [Baugh, Stone 1982]. An absolute wage level within and outside of teaching is also significant for career decisions. Higher opportunity wages outside teaching make teachers more likely to switch professions, and higher wages in teaching make a teacher less likely to quit either for career or family reasons [Dolton, Van der Klaauw 1999]. Paradoxically, this doesn't mean that former teachers earn more in other occupations. UK data show that those teachers who actually leave for other occupations in fact work for a 22% lower hourly-wage, work on average two hours longer, and work mainly in the non-professional occupations within the public sector [Frijters, Shields, Price 2004].

Individual characteristics that are linked to higher opportunities in the labor market like ability, qualification, and field of specialization may predict resignations from the profession. Teachers who score higher on standardized tests, graduated from more selective universities and specialize in chemistry or physics stay in teaching for a shorter length of time [Murnane, Olsen 1990]. That means that in the case of a large enough wage differential, the teaching profession is bound to lose the most qualified individuals to other occupations. But that

doesn't necessarily mean that it will lose its best teachers. A teacher's performance is usually measured by the educational attainment of her students on standardized tests. Judging by this measure, it is the least effective teachers who tend to exit the school district after a couple of years of teaching [Murnane 1984]. A more recent study confirmed that better female teachers tend to stay in the profession but there was no association between teaching performance and turnover for male teachers [Krieg 2006].

Attitudinal variables were also studied as predictors for teacher turnover. Here we consider the two psychological constructs most closely related to the idea of leaving the teaching profession: self-efficacy beliefs and occupational commitment. Both these constructs were extensively studied in application to teachers.

For teachers, professional self-efficacy means a belief by a teacher in her capability to manage her students and teach them something. The concept of self-efficacy was introduced by Bandura (1977) and was quickly shown to be a useful predictor of a teacher's classroom performance, academic performance of her students and overall job satisfaction [Ashton, Webb 1986; Pajares 1997; Canrinus et al. 2012]. Besides that, in some studies it was demonstrated that teachers with higher self-efficacy are more likely to stay in teaching [Glickman, Tamashiro 1982; Swanson 2012; Vieluf, Kunter, van der Vijver 2013].

Occupational commitment is a construct that characterizes the degree of one's attachment to a career role (in our case, a teacher) and willingness to work in it [Chapman 1983]. It is theoretically and empirically distinguishable from commitment to a particular organization [Hackett, Lapierre, Hausdorf 2001]. Commitment has received much attention in personnel turnover studies because it has been found to strongly predict intentions to quit [Martin 1982]. For teachers, occupational commitment is a predictor not only of teacher attrition, but also of teacher performance and burnout [Tsui, Cheng 1999; Rots, Aelterman 2008]. Notably, there exists a strong positive association between a teacher's self-efficacy and occupational commitment [Klassen, Chiu 2011; Chan et al. 2008; Canrinus et al. 2012].

In line with the seminal model of March and Simon (1958), we may structure the evidence on teacher turnover predictors along the lines of the ease and desirability of a move. Higher ability and better qualifications contribute to the mobility ease while making more desirable alternatives available. Low self-efficacy and low commitment levels contribute to the desirability of leaving the profession. Job satisfaction which is related to workplace difficulties and an individual's reaction to these difficulties makes an additional contribution to the desirability of resigning.

**Russian context**   Retention of teachers in the profession was a pressing social issue in Russia in the 1990s. The fast transition to the market economy accom-

panied with the relative neglect of educational policy on the part of the state was a scene for a growing teacher turnover rate and decreasing professional status. The situation was discussed by the teachers themselves, researchers and the public at large primarily in economic terms [Gimpelson, Treisman 2002]. At that moment, a severe cut in the state funding of education led to a drop in teacher salaries to the point where many teachers were forced to leave for better paid skilled and unskilled occupations. The teacher turnover rate of the 1990s had a lasting impact on the demography of Russian school teachers, forming what is known to be the effect of 'aging' the teacher population, since most leavers were early- and mid-career teachers [Rzhanitsyna 2000; Zajda 2003]. The mean age of Russian school teachers in 2013 was still higher than the cross-national average [Pinskaya et al. 2015].

The past ten years have seen changes in the economic situation along with significant policy modifications and finally an increase in the proportion of young teachers currently employed in schools [Pinskaya et al. 2015]. Following the economic line of reasoning, we may suggest that a more competitive salary was a factor in recovering the attractiveness of the teaching profession. Nonetheless, the issue of teachers' salary levels remains a publicly discussed problem [Zabaturina, Kovaliova 2010; Zijatdinova 2010].

Optimism about the current trend in teacher recruitment should be constrained with the evaluation of the prospects to retain the most able younger teachers at their posts in the long-term perspective. Some surveys show that the proportion of teachers who were considering leaving the profession as a career option is rather large. In a mid-1990s survey of teachers in Saint Petersburg, 22% of respondents reported that they could quit the job [Tumalev 1995]. In the latest TALIS survey with a nationally representative sample of teachers, 33% of respondents younger than 40 and 18% of those older than 40 reported that they wouldn't choose this occupation if they started their career anew [Pinskaya et al. 2015]. We are unaware of any empirical studies that have investigated factors influencing such a sentiment toward the profession among teachers in the Russian context.

The high rate of job leaving intentions (even as hypothetical as an answer to a questionnaire) is more noteworthy given the changes in the labor market and the career strategies that have occurred since the 1990s. Evidence exists that the younger generation of workers tend to perceive their career not as a life-long choice but as a more fluid experience, and are more eager to change occupations [Wise, Millward 2005], and teachers are no exception [Smethem 2007].

**Research questions**    The goal of our work is to explore the factors that make a teacher more tolerant to the idea of leaving teaching for an occupation with a higher wage. We test for the significance and relative importance of three groups of factors:

1. Factors pertaining to the individual's employment opportunities outside of teaching. Here we consider type of education (higher education degree not in pedagogy or specialized pedagogical education), as well as work experience within and outside of teaching.
2. Job-related stress factors. In this group we consider workplace difficulties that respondents associate with the idea of leaving the profession: conflicts with colleagues, conflicts with administration, difficulties with students, excessive work load, inadequate salary.
3. Attitudinal factors. We consider teacher's self-efficacy (a perceived ability to manage students and to teach them something) and an individual's emotional attachment to the teaching profession. We measure emotional attachment to the profession using a scale of occupational commitment.

**Data and method**

The empirical results are based on data collected in 2014 on a sample of Saint Petersburg schools. Two city districts were chosen for the study, one in the central part of the city and another on the periphery. Random sampling of schools was performed in each district. The proportions of gymnasiums[1] and schools with specializations in certain subjects matched the proportions in the general population[2]. Altogether, we surveyed 39 schools and 769 teachers. All the schools in the sample agreed to participate in the study. The survey procedure was conducted as follows. The research goal was explained to the school administration, after that each school received 20–30 questionnaires, depending on the school size, for teachers to complete themselves. These questionnaires were anonymous. In each school 11 to 30 teachers were surveyed (20 per school on average). Teachers filled in the written questionnaires after a professional meeting at school; completion of the survey was voluntary. Only teachers who work in secondary/high school were included in the study. 91% of participants were female, with a mean age of 45 years old and mean professional experience of 19 years.

The comparison of gender and age distribution in our sample with the data on the general population of Russian urban teachers for the year 2013 published by the Ministry of Education and Science [Ministry of education 2016] shows no significant differences in the distribution of gender and age categories used in the Ministry's data, whereas the comparison of the number of years of working experience shows

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[1] Gymnasium—is a type of secondary school in modern Russia with an emphasis on academic subjects. The name 'gymnasium' refers to a name of type of secondary schools in Russian Empire the diploma of which allowed the admission to the university.

[2] More details on the sample and the descriptive statistics can be found in [Ivaniushina, Alexandrov 2016].

that our sample has somewhat more teachers with less than 20 years of professional experience. This may be explained by our sampling strategy, as we did not include in the study teachers of special education schools, boarding and elementary schools. Besides that, it is possible that young and less experienced teachers are less likely to opt out of the survey. Hence, our sample may be considered generally representative of the chosen segment of Saint-Petersburg schools. Possible over-representation of younger teachers in our sample is consistent with the aim of the study—to analyze the risk of teacher attrition, which is more prominent in the case of younger teachers.

**Measures**
*Dependent variable*. The dependent variable for regression models was constructed from the answer to the question: 'If you were offered a job with a more attractive salary, but in a field unrelated to school, how difficult would it be for you to quit the teaching profession?', with a response scale from 1 (very easy) to 5 (very difficult).

*Characteristics of the employment situation*. We included several characteristics that might contribute to teachers' perception of the ease of leaving the profession. The first is a special type of education. All the teachers in our sample had higher education. But we distinguished teachers who graduated from a pedagogical institute/university from others (a binary variable). The second is the duration of job experience measured as the number of years teaching. The third variable was job experience outside of school, that is whether a respondent had ever had a non-school related job (a binary variable). The fourth variable was whether a respondent was engaged in private tutoring (a binary variable).

*Professional Difficulties*. The next group of measures was constructed from the replies to the question 'What problems and difficulties could make you leave your job?' The following possible answers were offered: 1) conflicts with administration; 2) conflicts with colleagues; 3) difficulties with students; 4) too much work load; 5) not enough payment; 6) lack of opportunity for personal growth and development. Respondents had to mark 'yes' or 'no' for every answer; thus six binary variables were constructed.

*Self-efficacy*. This construct was measured using a 5-item teacher efficacy scale (Gibson, Dembo 1984), translated into Russian and slightly adapted. Sample items are 'If I try hard, I can motivate even the most uninvolved students' and 'If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him.' A Likert-type response scale with four categories was used, ranging from 1 ('completely disagree') to 4 ('completely agree'). Previous research confirmed adequate internal consistency and a single-factor structure of the scale (R. D. Goddard and Goddard 2001). On our sample Cronbach's alpha was 0.72. The items were averaged, with higher scores indicating a greater level of self-efficacy.

*Occupational Commitment*. For measuring this construct we designed our own 5-item scale. Sample items are 'I would not like any other profession except school teacher for myself' and 'despite all the difficulties and problems, I like my profession'. Items were rated on a 4-point metric, ranging from 1 ('completely disagree') to 4 ('completely agree'). Analysis has shown that all items are combined in a single factor. The reliability coefficient (Cronbach's alpha) is 0.74. The items were averaged, with appropriate reverse scoring. Higher scores indicate greater commitment.

The gender of the respondent was included in all models as a control variable.

**Analytical strategy**

For the analysis of relations between the dependent variable—how hard it would be for a teacher to quit her job—and a number of explanatory variables, we used a series of multiple regression models[3], built using SPSS19.0 software. The logic of the analysis was as follows. The first model included explanatory variables describing education, job experience and gender. The second model included variables describing professional difficulties and self-efficacy. In the third model, we combined variables from the first and second models. Our last step (model 4) was to include professional commitment as an explanatory variable.

**Results**

Descriptive statistics for the variables are presented in Table 1. Most of the teachers in our sample had special pedagogical education, meaning they graduated from a pedagogical institute or university. Nevertheless, almost 60% of the respondents at some point of their lives had held a job outside of school and teaching. We might suggest that this happened mostly in 1990–2000, when a school teacher's salary was quite low, and teachers either had to supplement it by having an additional job, or had to leave school altogether for a while. Of the total sample, 20% are young teachers with experience of 5 years or less. Almost the same proportion are teachers with more than 30 years of experience; that is, persons close to retirement or already over retirement age. Private tutoring is quite common: almost every 6th teacher earns additional money by giving private lessons.

Regression models results are presented in Table 2. In the 1st model we introduced only the variables related to job experience and education. There is a positive relationship between the length of teaching experience and the difficulty in leaving the profession, but this relationship is very weak. If a teacher had ever hadanother job

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[3] Though the dependent variable is negatively skewed, residuals of the regression with the original variable are normally distributed; this means that variable transformation is not necessary.

Table 1. **Descriptive statistics**

| Variable name | % | Mean (SD) | Min-Max |
|---|---|---|---|
| Women | 92% | | |
| Teaching experience (in years) | | 18,8 (12,1) | |
| Higher pedagogical education | 67% | | |
| Ever had a job not in school | 57% | | |
| Engaged in private tutoring | 15% | | |
| Conflicts with administration | | 051 (0,50) | |
| Conflicts with colleagues | | 0,27 (0,44) | |
| Difficulties with students | | 0,17 (0,37) | |
| Too much work load | | 0,22 (0,41) | |
| Not enough payment | | 0,57 (0,50) | |
| No possibilities for personal growth and development | | 0,40 (0,49) | |
| Self-efficacy | | 3,00 (0,44) | 1,4–4,0 |
| Commitment to teaching | | 2,84 (0,65) | 1–4 |
| How hard to leave teaching profession | | 3,85 (1,20) | 1–5 |

outside of school, or if she was engaged in private tutoring, it would be easier for her to quit the teaching profession. This model has very small explanatory power and explains only 3.6% of the variance in the dependent variable.

In the second model we analyze how different problems and difficulties that teachers experience in their work affect their unwillingness to leave the teaching profession. We also include self-efficacy in this model as a concept reflecting teachers' perceived expectation of succeeding in their everyday tasks. As it turned out, not all factors that are perceived by teachers as work difficulties are related to their attitude toward leaving the profession. Out of six possible stress factors, only problems with students and low payment, and (to a lesser degree) excessive work load increase the perceived ease of leaving the teaching profession. On the contrary, conflicts with colleagues and administration and lack of opportunities for personal growth and development do not make it easier for a teacher to quit her job. Self-efficacy is positively related to the dependent variable, that is, the higher one evaluates herself on this parameter, the more difficult it would be for her to leave the teaching profession. It is worth noting that R-squared for Model 2 is much larger than for Model 1 and equals 16.4%.

The third model combined Model 1 and Model 2. Combining two models gives an additional slight increasein R-squared—18.3%. Signs of all the coefficients remain unchanged, while the significance of

Table 2. **Regression modeling result.**
**Dependet variable: how hard it would be to leave teaching profession**

| | Model 1 b (S.E.) | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Constant | 3,53 (0,20)*** | 2,82 (0,30)*** | 4,09 (0,21)*** | 1,14 (0,37)** |
| Higher pedagogical education | 0,17 (0,10) | | 0,22 (0,10)* | 0,04 (0,09) |
| Teaching experience (in years) | 0,010 (0,004)* | | 0,004 (0,004) | 0,000 (0,004) |
| Ever had a job not in school | −0,19 (0,10) | | −0,20 (0,10)* | −0,03 (0,09) |
| Engaged in private tutoring | −0,30 (0,13)* | | −0,19 (0,13) | −0,13 (0,11) |
| Gender | 0,20 (0,17) | 0,21 (0,18) | 0,27 (0,16) | 0,17 (0,15) |
| Conflicts with administration | | −0,17 (0,10) | −0,17 (0,10) | −0,10 (0,09) |
| Conflicts with colleagues | | −0,04 (0,11) | −0,05 (0,11) | −0,10 (0,11) |
| Difficulties with students | | −0,62 (0,12)*** | −0,61 (0,12)*** | −0,31 (0,11)** |
| Excessive work load | | −0,19 (0,10) | −0,23 (0,11)* | −0,06 (0,10) |
| Not enough payment | | −0,54 (0,09)*** | −0,52 (0,09)*** | −0,39 (0,09)*** |
| No possibilities for development | | −0,02 (0,09) | −0,06 (0,10) | −0,03 (0,09) |
| Self-efficacy | | 0,52 (0,10)*** | 0,51 (0,10)*** | 0,26 (0,10)** |
| Commitment to profession | | | | 0,77 (0,07)*** |
| R-square | 3,6% | 16,4% | 18,3% | 31,7% |

*** $p < 0,001$; ** $p < 0,01$; * $p < 0,05$.

some coefficients change (when it approaches the threshold value of $p = 0.05$).

Our final model (Model 4) includes one additional variable—commitment to the teaching profession. The model has much more explanatory power and explains almost 32% of the variance in the dependent variable. Comparison of the coefficients between the third and fourth models shows that while self-efficacy and job-related difficulties that were significant in Model 3 retain their significance, all variables related to education and job experience become insignificant. The final model demonstrates that commitment to the profession is the strongest predictor that a teacher finds it extremely difficult to quit her job, when other demographic and socio-psychological factors are controlled for.

**Discussion**    We estimated the relationship of the three groups of factors (individual employment opportunities outside of school, job-related stress factorsand attitudinal factors) with the perceived ease of leaving the profession. Our results show that most teachers find it hard to leave

the profession even when considering a hypothetical alternative with a higher wage. We found the two psychological constructs—occupational commitment and self-efficacy beliefs—to have the most prominent effect. The higher the efficacy and commitment, the harder it is for a teacher to consider leaving the profession. When these attitudinal factors are taken into account, other factors that we see as indicative of the opportunity for an individual's mobility in the labor market lose their significance. At the same time, some job-related stress factors retain their significance even when self-efficacy and professional commitment are taken into account. These factors are: difficulties with students, not enough payment and excessive workload, though their relationship with the attitude toward leaving profession is much weaker.

The design of our study does not allow us to draw conclusions about the direction of causality between self-efficacy and professional commitment on one side, and the ease in the attitude toward switching professions. Most probably, there is an interactional relationship among these attitudes during the teaching career.

Since there is no similar research based on Russian data, we can only compare our results to broader international literature. In a recent study, the internal structure of the Dutch teacher's professional identity was explored [Canrinus et al. 2012]. One of the factors identified by the authors, 'responsibility to remain in teaching,' is conceptually very close to our outcome variable. Among the most significant direct and indirect effects on it were classroom self-efficacy and emotional commitment to the profession, which directly corresponds to our findings.

One of our negative results is the most interesting from a theoretical and also a practical point of view. Our data do not support the hypothesis that early career teachers are more easily inclined toward the idea of switching professions. Some previous research has persuasively shown that the early years of teaching are crucial in making the decision to quit the profession, with a tipping point of 5 years of teaching experience [Struyven, Vanthournout 2014]. Authors argue that in the first years of teaching a teacher is still evaluating the prospects of an alternative career and can more easily decide to switch professions. Out results demonstrate that attitudes toward quitting the profession are independent of teaching experience[4].

Our data confirm that effects of the work experience are mediated by the self-efficacy (which grows with experience) and occupational commitment. Such a mediational relationship is in line with the findings in similar studies on personnel attrition [Karsh, Booske, Sainfort 2005]. In theoretical models of the personnel turnover process, at-

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[4] We have built models (not shown in this article) that compared young teachers with less than five years of teaching experience with more experienced teachers. These models also show no difference in attitude toward leaving the profession among teachers with different experience.

titude toward the job is also treated as a mediator between external variables and events and turnover intentions [Steel, Lounsbury 2009].

An important limitation of our study is that our sample represents only urban teachers, moreover teachers from urban schools in a megalopolis. Thus our findings may not be easily generalized to the entire population of Russian teachers, many of whom work in small towns and in village schools. It should also be noted that despite proven correlation between intentions and actual quitting behavior, populations of employees who intend to quit and those who actually quit the job may differ in demographic characteristics [Cho, Lewis 2012]. Hence, our results could not be generalized as an assessment of the group of teachers who will eventually leave the occupation, but it is still a useful estimate for the parameters of that population.

Summing up the contribution of this study, we wish to highlight two points. First, we present empirical data on predictors of teacher attrition in a population of Russian teachers, previously unstudied in this respect. Our findings indicate that those who regard higher wages as a motivator to quit teaching are likely to have low professional self-efficacy and low occupational commitment. Second, our results do not confirm that early career teachers are more tolerant to the idea of switching professions, contrary to expectations based on high turnover rates among young teachers evidenced in research on US teachers. This means that there are good prospects of retaining young teachers in the long run, provided that they keep a positive attitude toward the profession. Although occupational commitment is hardly likely to be influenced by policy measures directly, self-efficacy can be. Thus we suggest that programs aimed at improving the classroom self-efficacy of young teachers may be an effective policy measure for teacher retention.

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# Scope of Thesis Research in the Area of Physical Science Education

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**Abstract.** We have analyzed the topics of the candidate's and doctor's degree theses on theory and methods of teaching physics defended in 2000–2015. In the paper, we justify using a thesis database to identify the key areas of research in this field. We describe how thesis topics are distributed across levels of education (secondary and tertiary), how topics of the theses dealing with tertiary education are distributed across specializations and areas of research defined by the formal specialty description. We also identify the most active research topics in theory and methods of teaching physics as well as top-priority research avenues for the foreseeable future.

**Keywords:** physics education, school, higher education institution, education program, thesis research, physics syllabus, computer information technology, inclusive education.

Information society of the 21st century is characterized by a controversial and ambivalent understanding of the role of science in its evolution. On the one hand, public opinion allows that scientific breakthrough is critical for progress, social wellbeing, and the quality of life. On the other hand, "the positive image of science is accompanied by some negative implications entailed and risks associated with environmental deterioration, industrial disasters, and a menace to all mankind as such" [Solomin, Laptev 2015]. Natural sciences, including physics, are the first to be held accountable, as it was research into nature that gave birth to engineering, technology, technocratic rationality, and, ultimately, the "technogenic civilization".

Obviously, this attitude to the role of science stems from the utilitarian approach to assessment, which highlights what science can give the humanity in a year, two, or ten. Meanwhile, it sidelines the fundamental role of science in social development, which is not reduced

to immediate research applications, as well as personal development of researchers as an additional effect.

However, there is growing recognition of the fact that the importance of science goes far beyond its applications. As outstanding physicist Erwin Schrödinger said more than half a century ago, "We tend to forget that all natural sciences have to do with universal human culture, and scientific discoveries that seem to be the most progressive and only understandable by the select few at the moment are still meaningless outside their cultural context" (cited by [Prigozhin, Stengers 2014: 31]). The history of science, physics in particular, has seen numerous examples of how a major scientific discovery received no acceptance or demand from its contemporaries, being mismatched with the general cultural context, or when different researchers made the same discovery, of which the idea had been in the air, virtually at the same time, by historical standards.

"Recent research has been calling us more and more away from treating humans and nature as opposites. Our knowledge about humans is growing ever more harmonized with that about nature, reducing the gaps and smoothing the contrasts," emphasized Nobel Prize winner Ilya Prigozhin [Ibid.: 18]. It means that today's science produces outcomes far beyond the pragmatic goals of wealth accumulation—it actually shapes a new kind of thinking. Someone who investigates into nature engages in spiritual development. Society of the future will need first of all creative, competent business people with universal yet paradoxical minds, capable of finding their way in the abundance of varied information, analyzing and screening it quickly to make the right decisions. In the ever-changing world, it becomes more and more difficult to secure oneself a full-fledged life using established stereotypes and behavioral templates. In fact, we have to be researchers and scientific thinkers more and more often [Larchenkova 2013]. This explains to a large extent the recent increase in the interest for research in all fields including education.

The interdependence of science and education is clear: gaining new knowledge is always associated with transferring it to the generations that follow. The goals and meaning of education are undergoing fundamental transformations due to the global changes in the life of modern society: the coexistence of numerous different cultures, the rapidly growing pace of life, the increasing amount of information, the emergence of new technology and means of communication, etc. In a world of head-spinning change, we ought to teach not only what has been accumulated by the previous generations but also what can happen in the future, which means that students should be armed with possible scenarios of the future they will have to live in. Development of scientific enquiry skills thus becomes the key prerequisite for satisfying the social demand for upraising and educating the man of the future. This goal has been given priority in the current modernization program, which seeks to integrate research activities at all levels

of education and solidify the methodological component of learning. Education today should represent an integral process combining *science components* that define the content, methods and goals of education, *teaching components* that determine the technology, techniques and methods of transferring knowledge, skills and traditions, and *research/heuristic components*.

Physics has made an unquestionable contribution to general human culture, having produced effective scientific thinking strategies, the scientific worldview, and research methodology. Physics was the cradle of the very first ideas of the principles of causality, complementarity, uncertainty, and correspondence, which are now classified as methodological and interdisciplinary. This status of physics is the reason why it should be taught at all levels of education.

## 1. Thesis topics as an indicator of developing trends in scientific research

Present-day research studies are projected and carried out in the framework of various research programs, but theses hold a special place among them, determined by the social demand for research outcomes as such (applied and culturological aspects) and the development needs of science itself (fundamental aspect) [Solomin, Laptev 2015].

A thesis is supposed to present novel, theoretically and practically significant research findings that offer a solution to a scientific problem. The paradox of modern thesis assessment criteria is that thesis is understood first of all as a tool to assess the author's scientific skills but not as a mechanism for developing scientific knowledge in a specific field. Academic degrees open the door to the world of science for all holders.

The annual number of theses defended in pedagogical sciences was constantly growing during the last two decades, up until 2014. Apart from that, theses devoted to teaching various subjects including physics have now acquired some specific features.

More and more educational institutions at all levels combine teaching activities with research and experiments. Besides, some successful instructors consider it necessary to consolidate their unique teaching techniques or observations in the form of theses [Novikov 2003]. Pedagogical experiments are now allowed to be conducted at the author's workplace, and no complicated procedure to acquire the status of a testing site is required anymore. In addition, recent graduates from teacher training universities also have access to postgraduate studies in theory and methodology of education and teaching, which contributes to the number of academic degree seekers.

Research and project technologies are prioritized today at all stages of the learning process, but the best part of the teaching force is not ready for this kind of work. Quite naturally, university instructors and school teachers who have never been engaged in any research project simply possess no skills required to organize research activi-

ties of students. According to survey data, teachers often find difficulty articulating and justifying the goal of their research (53%), forecasting outcomes, selecting means and methods of research (52%), summarizing and presenting research findings (47%) [Lebedeva 2010]. This should come as no surprise, as objectives of a teacher and those of a researcher are essentially different [Novikov 2003]. Teacher seeks first of all to achieve a high level of academic performance, while researcher aims at obtaining new scientific knowledge, explaining instructional phenomena, and forecasting the outcomes of pedagogical influence.

For a school or university teacher, academic degree is an exclusive and very meaningful indicator of their professional growth, which attests the breadth of their knowledge, their systems thinking skills, their ability to identify and solve problems as well as to organize a learning process to meet present-day requirements. From this perspective, one cannot but welcome the growing number of theses in pedagogy defended by practicing teachers, particularly given the fact that selecting a major and a topic of research is a challenging task for many of them.

Any thesis begins with justifying the topic of research. The range of topics in pedagogy is so wide, it may seem that choosing a fresh one for research should not present any problem. However, prospective researchers experience the most difficulty finding "their own place in the field", identifying the area that would be the closest to their academic interests, finding out how well that area has been studied so far, which unsolved problems they can analyze or which solved ones can be resolved in another way. Meanwhile, it is important to ensure that the chosen topic is justified by objective practical and theoretical requirements, on one hand, and fits in the existing cultural situation regardless of momentary factors, on the other hand.

In this paper, we study theses in specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics, Secondary and Tertiary Education Levels)". However, we do not evaluate researchers' expertise (assuming that a successfully defended thesis is an evidence of scientific skills and, consequently, its topic is consistent with the formal specialization description). Instead, we analyze their topics as an indicator of developing trends in scientific research.

The article seeks to identify research directions in the abovementioned specialization, the importance of which is determined not only by the current social demands but also by more long-term development trends.

**2. The good reason behind identifying research problematics based on thesis topics**

We find it acceptable to use a thesis database to identify research problematics in physics theory and teaching methods based on the following factors: (i) research findings are subject to pre-reviews prior to publication; (ii) theses are easily available for study, distribution,

and use of their findings; (iii) a defended thesis is an indicator of research success.

So, first of all, the critical components of research are pre-reviewed at the stages of thesis preparation and defense. The quality of research and validity of research results are ensured upon evaluation of research findings and their publication in print and electronic media.

The existing level of scientific communication and the infinite possibilities of presenting, storing and spreading information in the Internet necessitate a thorough evaluation of research products. In a situation where anyone can publish their work, there has been a sharp increase in the overall number of publications and an obvious reduction in their average quality, while an in-depth analysis of works is becoming not that easy. That is why it does not seem productive to include all publicly available publications in the analysis of research topics. Ideally, relevant and valuable information should come from peer-reviewed journals, some of which can be found on the list recommended by the Higher Attestation Commission (VAK) [Belyaeva, Shubina 2014]. Thesis findings are published in the form of articles in journals from the list.

As for publications devoted specifically to methods of teaching physics, there are only two Russian journals specialized in this area: *Fizika v shkole* and *Fizicheskoe obrazovanie v vuzakh*, which have no foreign analogues that we know of. A large part of articles within specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics)" are published in multidisciplinary journals. Such journals are designed to develop an integral perception of the science industry, so their requirements for the content of articles concern not only the subject-related aspect but also the cross-disciplinary one. Moreover, as soon as articles are prepared at various stages of research, they can present not final but provisional results, and length restrictions make authors include only fragmented or rather generalized research data, omitting a good deal of details. The same applies to conference proceedings.

Second of all, theses are easily available for study, distribution, and use of their findings today. Degree seekers used to spend a lot of time in reference rooms of Russia's central libraries, but computer information technology recently applied to library services has not only allowed creating online thesis catalogues available to anyone but also provided the opportunity to access theses and extended abstracts remotely. A high availability of e-catalogues and texts imposes stricter requirements to justifying the significance, novelty, and usefulness of prospective research by degree seekers. Of course, an author has a chance to present their findings in more details by publishing them in a monograph, but it will hardly attract more readership. Nowadays, monographs are published in limited quantities, have no effective distribution system and thus often do not reach their reader. Under the existing circumstances, theses are easier to access than monographs.

Consequently, a thesis catalogue, e. g. that of the Russian State Library, can serve a reliable base for analysis of research topics in the selected field.

Third of all, thesis is a good indicator of successful research in pedagogy. Institutions and teams engaged in research in this field present their results in a number of ways: as research performance progress reports, published articles and monographs, published textbooks and guidance materials, or new learning equipment and electronic resources. Still, results reported in a thesis, prepared and defended using the research materials, are a key indicator of successful research. As an example, we can refer to Marina Demidova's doctoral thesis *Metodicheskaya sistema otsenki uchebnykh dostizheniy uchashchikhsya po fizike v usloviyakh vvedeniya FGOS* [A System of Methods to Assess Academic Performance in Physics after the Introduction of the Federal State Education Standard (FGOS)] (Moscow State Pedagogical University, 2014), which she wrote in the course of a many-years cooperation with the Federal Institute of Pedagogical Dimensions in the development of USE (Unified State Exam) tests in physics.

Therefore, in the object of our study, which is research in theory and methods of teaching physics, we can identify the subject, which is conformance of research problematics to the existing social demands for physics education as well as to the development prospect justification requirements. The analysis database is limited to theses in specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics, Secondary and Tertiary Education Levels)".

The key research methods include qualitative and quantitative analysis of research directions observed in the database, comparison of these directions to those stipulated in formal specialization descriptions as well to the requirements imposed by the modern level of education and social development, and statistical processing of the data obtained.

## 3. Analysis of the topics of theses devoted to theory and methods of teaching physics

In order to draw up a list of theses in specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics, Secondary and Tertiary Education Levels)" defended between 2000 and 2013, we used the online thesis catalogue (http://diss.rsl.ru) of the Russian State Library, as it provides quite a complete picture of the given period.

Data for the period 2014–2015 is based on the upcoming defense announcements posted on the VAK website, so it is rough. Using this method, we traced a total of 520 works.

Figure 1 shows that 2004 and 2006 were the peak years of interest for methods of teaching physics among grade seekers, the number of such works plummeting in 2011. However, it would be wrong to talk about a decreasing enthusiasm for research in this area based on this data alone, because the period in question witnessed some or-

Figure 1. **Number of theses defended**

| Year | Candidate's degree | Doctor's degree |
|------|------|------|
| 2000 | 38 | 10 |
| 2001 | 19 | 3 |
| 2002 | 29 | 7 |
| 2003 | 32 | 8 |
| 2004 | 53 | 3 |
| 2005 | 40 | 8 |
| 2006 | 55 | 7 |
| 2007 | 36 | 7 |
| 2008 | 25 | 3 |
| 2009 | 26 | 4 |
| 2010 | 32 | 3 |
| 2011 | 15 | 1 |
| 2012 | 10 | 4 |
| 2013 | 9 | 4 |
| 2014 | 10 | 5 |
| 2015 | 14 | 0 |

■ Candidate's degree
■ Doctor's degree
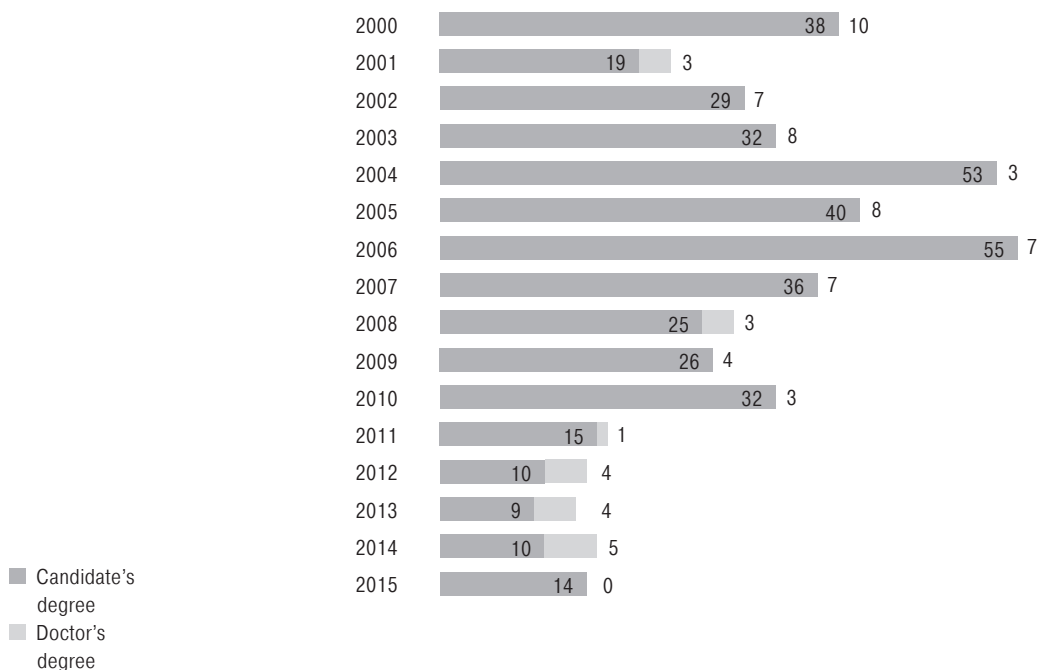
Figure 2. **Thesis topics distributed across education levels involved**

| | Candidate's degree | Doctor's degree |
|------|------|------|
| Secondary education | 260 | 36 |
| Tertiary education | 162 | 31 |
| Physics education as a whole | 20 | 11 |

ganizational reforms that changed the defense procedure and the way thesis committees worked. Time will tell whether this downward trend is a persistent effect or only an adaptive response to the new context and whether the change in the requirements will enhance the quality of theses or complicate the defense procedure, scaring away prospective researchers.

As we can see from Figure 2, most theses focus on methods of teaching physics at school (57%), a large proportion is devoted to problems in tertiary education (37%), and only few studies investigate into physics education as a whole, including the lifelong learning aspect (6%).

Among theses devoted to secondary education, 15% study high school problems (15%) and 25% focus on junior high school. 60% of works assume that their problem-solving approaches can be equally applied to any level of secondary education or provide continuity of teaching physics in terms of secondary education.

Theses dealing with tertiary education suggest methodological systems and conceptions for teaching physics in higher education institutions of various specialization: medical, military, technical, pedagogical, and classical universities (Fig. 3). Nearly half of the studies about teaching physics in universities investigate into teacher training.

Only 11 theses in 16 years (2000–2015) explored teaching physics at the level of vocational education, leaving the area almost uncovered.

The formal description of specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics, Secondary and Tertiary Education Levels)" defines four areas of research: 1) methodology of teaching physics; 2) goals and values of physics education; 3) methods of ensuring and evaluating the quality of physics education; 4) theory and methods of teaching extracurricular and out-of-class awareness-raising activities (рис. 4).

These four areas are further divided into narrower research directions. With a view to find out which areas and directions were the most popular in theses devoted to theory and methods of teaching physics, we thought it possible to judge about problematics based on thesis topics, as they were supposed to give the idea of the problem analyzed, according to the requirements.

Although the boundaries between the areas are rather conventional and research can be conducted at the interface of two or even three closely related areas, we were able to see clearly:

- the distribution of thesis topics across the areas;
- the most popular areas;
- the unexplored areas.

As Figure 4 demonstrates, the highest proportion of the works is devoted to the methods of ensuring and evaluating the quality of physics education (65%). The formal specialty description divides this area into 31 directions. Within the thesis database analyzed, the following areas are investigated most often (hereinafter as a percentage from the number of theses in the given area):

- Theorizing the best practices in teaching and education (13%);
- Methods, means, forms and techniques of physics education, awareness-raising and self-training (12%);
- Development of methodological conceptions for the content of physics education and the process of relevant knowledge acquisition (11%);
- Interrelation, continuity and integration of subjects and areas in the structure of secondary and tertiary education (9%);
- Monitoring of teaching and educating quality at different levels of instruction (8%).

Figure 3. **Topics of theses devoted to teaching physics in tertiary education distributed across types of educational institutions**



Tertiary education
Vocational schools, 6

Classical universities, 4

Other universities, 20

Teacher training universities, 45

Military universities, 5

Medical universities, 5

Engineering universities, 15
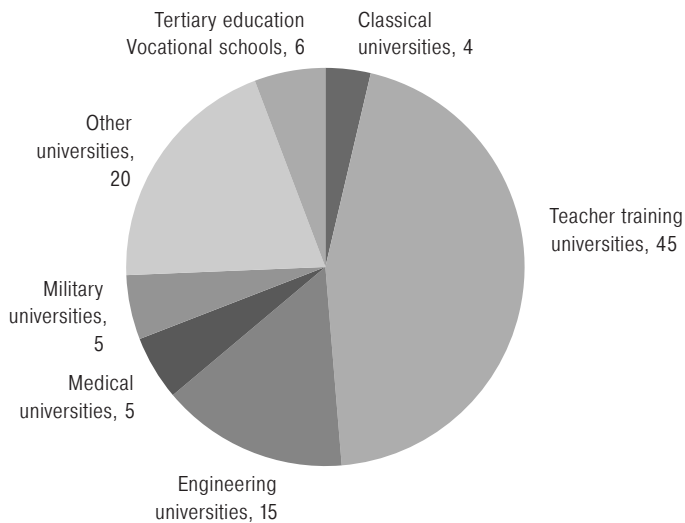
Figure 4. **Thesis topics distributed across areas of research defined in specialty 13.00.02 formal description**



Теория и методика внеурочной, вне-классной, внешкольной учебной и воспитательной работы по предметам, 3

Методология предметного образования, 18

Цели и ценности предметного образования, 14

Технологии обеспечения и оценки качества предметного образования, 65
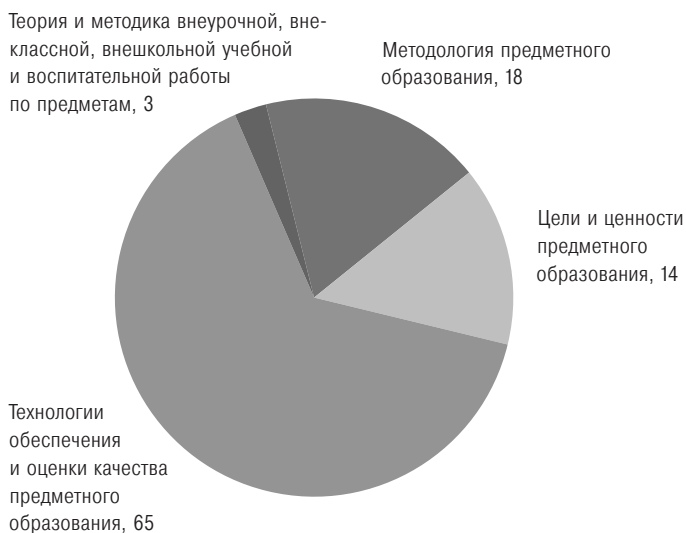
Researchers in the area "Methodology of teaching the subject" work in the following directions:

- Opportunities and limitations of applying generic scientific knowledge acquisition methods to methodological subject teaching conceptions (28%);
- Trends in the development of different methodological approaches to organizing the learning process in physics (21%);
- General regularities of the learning process in the context of using the didactic opportunities of information and communications technology (16%).

Researchers within "Goals and values of physics education" tend to prioritize the development and awareness-raising opportunities of subjects (58%) and the problems of developing a positive motivation for learning, a philosophy of life, and a scientific worldview in students (24%).

Since formal specialty description should allow for an ultimately close examination of thesis for compliance to research specialty, it defines 51 directions of study. Within the bulk of theses on theory and methods of teaching physics, we found the following directions to be virtually undemanded:

- Specifics of obtaining knowledge while digesting the content of areas of study, disciplines, subjects, or courses (2 theses);
- Theory and practice of developing state education standards at different levels and indifferent areas of physics education (1 thesis);
- Theory, methods and practice of designing syllabi of different types and levels;
- Design of syllabi for educational institutions of different types and levels;
- Performance assessment of syllabi of different levels and content;
- Techniques of designing syllabi for basic and supplementary education;
- Development of methodological requirements for new-generation subject-related study materials;
- Analysis of positive and negative effects (in terms of education) of using information and communications technology at different levels of physics education;
- Preparing physics teachers to work in the supplementary education system.

**4. Design and testing of physics syllabi as a promising research direction**

The lack of theses in the abovementioned directions may be explained by the existing situation in Russian education, which complicates the procedure of pedagogical experiment and limits the focus of the ac-

ademic teaching community to the problems that appear to be the most important in the given period of time. As Vitaly Ginzburg would say, some problems are classified as "especially important" not because others are not important but because they are the focus of attention today, which does not mean they won't be replaced by something else tomorrow [Ginzburg 2004].

Let us analyze the relevance of the aspects of theory and methods of teaching physics that are somehow neglected by degree seekers right now but can thrust to the fore any time soon.

The overview of directions above shows that the least number of theses has been dealing with design, testing and performance assessment of physics syllabi for educational institutions of different types and levels reflecting the content of modern physics education of different types and at different levels. We believe that the main reasons for neglecting this crucial direction are as follows.

In terms of secondary education, the reason is the length of the research cycle and the time required for syllabus testing. As school physics is studied from grade 7 to grade 11, only performance tests for a designed syllabus will take at least five years, and additional time is needed to make and test adjustments. Candidate's and doctor's degree studies last three years each. It becomes quite obvious that external factors make it impossible for a researcher to cram a full-featured experiment into this period so as to provide an exhaustive assessment of syllabus performance, especially using a limited database. At the same time, engaging a research team into a years-long project to analyze their work later and use this data to prepare a thesis is an extremely difficult task.

As for tertiary education, degree seekers neglect design, testing and performance assessment of physics syllabi due to frequent changes in standards and education programs. It would seem that this area provides even more opportunities for experimenting. However, the attempts to regulate the process of syllabus development that had been snowballing since the mid-1990s necessitated the introduction of education standards, which have been changing alarmingly quickly, too (GOS, FGOS-3, FGOS-3+, and FGOS-4 looming on the horizon). Standards come and go faster than syllabi can be developed, let alone tested [Gorokhovatsky et al. 2015]. The unfolding situation can be described quite precisely by the words of Polish satirist Henrik Yagodzinsky: "Changes for the better follow each other so fast that good things have no time to take hold."[1]

The task of upgrading the content of physics education in the present-day context is complex and ambiguous, which is another reason common for all levels of education. The need for upgrading and bring-

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[1] Dushenko K. (ed.) (2000) *Bolshaya kniga aforizmov* [The Big Book of Aphorisms], Moscow: EKSMO-Press. P. 705.

ing physics syllabus in line with scientific development and utilitarian requirements has been discussed for a very long time within the framework of modernization of Russian education as such. However, the mission is not anymore possible to accomplish using the conventional encyclopedic, strictly consequential approach to building the syllabus, and here is why:

1. Scientific and technological knowledge has been growing and accumulating explosively. Transition from linear to exponential growth of knowledge and technology in many fields of science was mentioned by presenters at FUTUREMED Conference held in Silicon Valley in January 2013. Humans produced more information in three years (2010–2012) than for the whole period of their existence up to 2008 [Kurakova et al. 2014].
2. The lag time between scientific discovery and technology implementation has shrunk. The whole cycle that used to take decades now only takes 5 to 7 years.
3. Modern physics is so complicated and abstract that integration of scientific achievements into the learning process requires a rigorous selection and adaptation of material to age-specific and cognitive capabilities of school students as well as to specific major requirements in universities.

Selection and adaptation of learning material is not too demanded by degree seekers in our database. For example, theses in "Development of physics education content" only account for 3% of all works; they are devoted to adapting some physics topics for school textbooks. "Problems of modeling course structure and content" are analyzed in 2% of theses, and all of them deal with higher education. The near-zero amount of works devoted to selection and adaptation of learning material does not mean at all that the solution has already been found. School syllabi are still designed to teach classical physics mostly, despite the fact that modern development of engineering and technology relies on the physics discoveries of the 20th century in the first place. Indeed, the classical approach to describing physical phenomena provides a clear illustration of macrocosm that fits a school student's living space adequately, and its methods are optimal for teaching teenagers. Yet, it only means that the problem of learning material selection and adaptation is inherently controversial and hard to solve.

A number of theses offer syllabi designed by authors as possible applied results of research, yet all of them most often illustrate the author's arguments instead of being the subject of research. Therefore, identifying the ways to optimize the volume, content and structure of physics syllabi based on thesis findings appears to be a really pressing issue for the moment.

**4.1. Possible research avenues**

Possible ways of syllabus optimization are determined by the intrinsic logic of physics as a science, which can be summarized in simple terms as follows:

- Finding the universal visualization of interactions and studying nonlinear phenomena;
- Developing computational physics and teaching mathematical modeling as a new research methodology [Kadanoff 1994; Ginzburg 2004; Kondratyev, Priyatkin 2006].

This is not to say that modern trends in scientific development should be immediately and explicitly "transplanted" to physics education at all levels. The problem of reducing the gap between physics as a science and physics as a subject cannot be solved "at the level of child's perception", as Anatoly Gladun mentioned rightfully [Gladun 2010]. However, these trends can and should serve the key guidelines in developing and improving physics education. We are not talking here about radical measures like abandoning specific phenomena and laws in favor of nonlinear systems and high-level abstract generalizations, or replacing experiment with computer modeling, or neglecting the didactic principle of simplicity. What we suggest is looking for methodological opportunities to set priorities in teaching physics that matter the most today.

"Physics has sprawled and branched out so much recently that it becomes hard to see the forest behind the trees, hard to see the whole of modern physics with one's mind's eye. Meanwhile, a whole picture does exist, and physics does have a core amid all of its branches. This core consists of the fundamental concepts and laws." [Ginzburg 2004: 12] Obtaining knowledge conceptually, at the level of progressive ideas, scientific notions and theoretical models, should provide the opportunity to rationalize the composition of scientific knowledge required and sufficient for digestion by various types of learners. This way of obtaining knowledge will enable the development of physics comprehension abilities that are indispensable for both doing research in physics and nurturing thinking skills demanded in any industry today.

Development of mathematical modeling as a new research methodology and its integration in physics education is directly related to the ongoing informatization of science and education. Focus on nonlinear phenomena is increasing largely because using modern computing hardware allows analyzing problems that used to be considered unsolvable.

These trends of modern physics development are closely interdependent. That is why "teaching physics should first of all proceed from the assumption that physics is the ultimate culture of modeling" [Gladun 2010: 48]. Adding elements to simplest models makes them look more realistic; the ever more complex research-related calculations

can be done using computers; findings that require knowledge of the fundamental concepts and laws to be deeply comprehended can provide the possibility of going beyond linearity.

Scientific justification is needed to determine to what extent and how exactly these modern development trends could be reflected in syllabi of different types at different levels of education, and this could likely make a good thesis topic. Given that any model has only part of source object's properties, "it should be kept in mind that idealization "takes revenge for itself", giving birth to paradox and confusion" [Ibid.: 50]. For instance, school physics already involves a good deal of models (point mass, weightless inextensible cord, ideal gas, closed loop, mathematical forms of physical laws, and others). Nevertheless, if a teacher pays little attention to their applicability conditions and does not show ways and possibilities of going beyond models, students will treat those models as sophisticated and useless. Indeed, why learn something that has nothing do to with real life? At the same time, shifting the focus to particular phenomena will give them the impression of disorganized isolated cases that are impossible to memorize.

At present, it is often intuition in practice that determines to what extent and in what combinations school-level physics syllabus contains methodological principles and fundamental or purely physical laws, and the latter are often preferred. Natalya Menchinskaya described the balance of general and specific in learning as follows: "Mastering philosophical concepts—matter, consciousness, primacy of matter over consciousness, etc.—requires a wealth of more specific natural knowledge, some of which should be based on specific sense experience. At the same time, mastering highly abstract concepts allows learning the world in all of its specific diversity." [Menchinskaya 2004]

Therefore, problem number one is justifying and designing physics courses based on general methodological principles—symmetry, relativity, etc.—whose biggest benefit, once mastered, will be that students will be able to see clearly the model-like nature of human knowledge and ideas about the outside world, identify the extent of their validity, and apply this information adequately [Kondratyev, Priyatkin 2006; Mayer 2012]. However, to make a course meet such requirements, selection of specific physical knowledge and paths of mastering should presumably become more varied, "nonlinear"—in this case the course will reflect by itself the trends in development of modern physics as a science.

## 4.2. What technology can be used to support physics education under the new conditions

The most active research area is module-based learning, i. e. breaking the content into invariant and variant components (Zaleznaya T. *Individualno orientirovannoe obuchenie budushchego uchitelya fiziki na osnove modulno-reytingovoy tekhnologii* [Individually-Oriented Training of Physics Teachers on the Basis of the Module and Ranking Technology] (Astafyev Krasnoyarsk State Pedagogical Univer-

sity, 2006); Lozinskaya A. *Modulno-reytingovaya tekhnologiya kak sredstvo povysheniya effektivnosti obucheniya fizike v uchrezhdeniyakh srednego professionalnogo obrazovaniya* [Module and Ranking Technology as a Way of Enhancing the Effectiveness of Teaching Physics in Secondary Vocational Education Institutions] (Ural State Pedagogical University, Yekaterinburg, 2009); Shermadina N. *Izuchenie mekhaniki v osnovnoy shkole na osnove modulnoy tekhnologii obucheniya* [Teaching Mechanics in Secondary School Using the Module-Based Technology] (Moscow State Pedagogical University, 2009); Batina Y. *Formirovanie umeniy samostoyatelnoy uchebnoy deyatelnosti uchashchikhsya osnovnoy shkoly pri obuchenii fizike na osnove tekhnologii modulnogo obucheniya* [Developing Self-Learning Skills in School Students While Teaching a Module-Based Physics Course] (Vyatka State University of Humanities, Kirov, 2009); Petrova T. *Invariantny podkhod k proektirovaniyu variativnogo obucheniya fizike* [An Invariant Approach to Design of Variative Teaching] (Far Eastern State University, Vladivostok, 2006); Popovich I. *Variativnost v obuchenii fizike kak didakticheskoe uslovie povysheniya kachestva znaniy uchashchikhsya v sredney shkole* [Variation in Teaching Physics as a Didactic Prerequisite for Increasing the Quality of Knowledge in Secondary School] (Chelyabinsk State Pedagogical University, 2007), and others).

However, introduction of module-based learning, discriminating between invariant and variant parts, and any other new approaches to organizing the learning process cannot solve the problem of building a modern physics course—a fundamental decision regarding the content of such course should be made in the first place. Besides, organizational challenges associated with implementation of new approaches may give rise to contradictions with the principles of continuity, consistency, and conformance to the basic science.

Nonlinearity in selecting the content and building the course inevitably entails changes to the basic unit of learning, e. g. learning situation. Degree seekers apply a lot of effort to elaborate conditions and identify opportunities for project activities in teaching physics (Tretyakova S. *Estestvenno-nauchnye proekty kak sredstvo formirovaniya uchebno-informatsionnykh umeniy u uchashchikhsya pri obuchenii fizike* [Science Projects as a Means of Developing Learning and Information Skills in Physics Students] (Moscow State Pedagogical University, 2004); Barkova Y. *Podgotovka uchashchikhsya k proektnoy deyatelnosti pri obuchenii fizike v sredney shkole* [Preparing Students to Project Activities while Teaching Physics in Secondary School] (Astrakhan State University, 2006); Loboda Y. *Proektnaya deyatelnost v oblasti fizicheskogo eksperimenta kak sredstvo formirovaniya professionalnykh kompetentsiy u studentov pedagogicheskogo vuza* [Physics Experiment Projects as a Way of Developing Professional Competencies in Prospective Teachers] (Tomsk State Pedagogical University, 2006); Vechkanova N. *Proektno-modulnaya sistema*

*obucheniya fizike v osnovnoy shkole kak sredstvo razvitiya uchash-chikhsya* [Project and Module Technology of Teaching Physics in Secondary School as a Student Development Tool] (Moscow State Pedagogical University, 2009); Grudinina V. *Formirovanie professionalnogo samoopredeleniya obuchayushchikhsya v proektnoy deyatelnosti po fizike v obshcheobrazovatelnoy shkole* [Getting General School Students to Construct Their Professional Identity through Project Activities in Physics] (Moscow Region State University, 2015), and others).

Another promising area is based around considering the unit of learning to be a physics problem and elements of problem solving in all other types of cognitive learning activities. This offers an opportunity to design physics education on the basis of training problems and thus provide the necessary level of information richness and solidity of basic knowledge, on the one hand, and effectiveness and flexibility of the content of physics as a subject, on the other hand (Vorobyev I. *Uchebnaya zadacha kak metodicheskaya osnova postroeniya kursa fiziki* [Training Problem as the Methodological Basis of a Physics Course] (Novosibirsk State Pedagogical University, 2002); Larchenkova L. *Obrazovatelny potentsial uchebnykh fizicheskikh zadach v sovremennoy shkole* [Educational Potential of Training Problems in Modern School Physics] (Herzen State Pedagogical University of Russia, 2014)).

Researchers are starting to explore this topic (8% of theses), though mostly in relation to higher education so far: reforms are easier to implement in universities than in schools because the former are more willing to change the way learning is organized (e. g. to introduce module-based courses) and have intellectually mature students.

The new content of physics education and the new approaches to teaching physics necessitate justification of creating new training aids and analyzing their effectiveness. Integration of information technology is one of the key factors that drive changes in the methods, means and forms of teaching physics. It provides illustrative properties of a new type, allowing to support courses with electronic materials, and generates new instructional models (distance learning, flipped classroom, etc.) and assessment tools. Various aspects of applying information technology in teaching physics are quite popular among degree seekers, with 13% of all theses devoted to the topic, e. g. Nazarov A. *Informatsionnye i kommunikatsionnye tekhnologii v sisteme otkrytogo obucheniya fizike v regionalnom vuze* [Information and Communications Technology in the Physics Open-Learning System of a Regional University] (Herzen State Pedagogical University of Russia, 2005). Another vital aspect of modern physics education is using computer for its original purpose, i. e. to perform a large amount of mathematical calculations within a short time. The possibility of doing such calculations right then and there transforms the requirements for mathematical background of students [Laptev, Shvetsky 1996], on the one hand, and enhances the role of qualitative methods in teach-

ing physics at all levels of education, on the other hand. These methods become especially important as educational priorities change, bringing the development of methodological knowledge and skills to the foreground. Knowing the qualitative methods of analyzing physical situations, students can not only explain specific physical phenomena but also predict the nature of different scenarios and new physics phenomena in some cases.

The opportunity of expanding the range of physics problems by involving computational methods and programming was first demonstrated at the very beginning of introducing computer technology to the learning process [Kondratyev, Laptev 1989; Bursian 1991]. Later, it was developed in two directions of student activities: (i) analyzing pre-configured computer models by modifying widely the parameters of analyzed systems and (ii) actually programming physical phenomena and processes in high-level languages. The existing software allows using mathematical packages (MatCad, MatLab, Maple, etc.) to construct more complex models of physical phenomena even without any deep knowledge of specific computational procedures or programming languages (see, for instance, [Kondratyev, Lyaptsev 2008]).

Creating computer models with the help of mathematical software is available not only to university students but also to school students under the guidance of teachers. This approach is revolutionary for general school practice and certainly requires research and methodological support. However, only 10% of theses devoted to using information and computer technology in teaching physics address using the technology to teach students computer modeling of physical processes so far, and they mostly deal with university education.

Of course, only highly qualified teachers with a strong background in the field can guide students in this type of work at any level of education. Unfortunately, the ongoing reduction of the physics component in curricula of teacher training universities is clearly going against these practical needs [Gorokhovatsky et al. 2015]. Nevertheless, researchers address the need for physics teachers to master new activities more and more often, which also proves the importance of the topic (Oskina O. *Metodika obucheniya osnovam kompyuternogo modelirovaniya budushchikh uchiteley fiziki v pedvuze* [Methods of Teaching the Basics of Computer Modeling to Prospective Physics Teachers] (Samara State Pedagogical University, 2000); Popov S. *Vychislitelnaya fizika v sisteme fundamentalnoy podgotovki uchitelya fiziki* [Computational Physics in the Fundamental Physics Teacher Training System] (Herzen State Pedagogical University of Russia, 2006); Savateev D. *Kompyuternoe modelirovanie v izuchenii fizicheskikh osnov elektromagnitnykh yavleniy v kursakh obshchey fiziki i spetsialnykh distsiplin tekhnicheskogo vuza* [Computer Modeling in Teaching Physical Principles of Electromagnetic Phenomena in General Physics and Specialized Discipline Courses of a Technical University] (Murmansk State Technical University, 2007)).

**4.3. Which conditions should be prioritized to develop physics education in the new context**

Effectiveness of modern physics education is determined not only by its planned content and technology used in the learning process. It depends to a large extent on the quality of students and development opportunities they are offered. It is vital to identify students with not only research skills but also a disposition for research. Such students are the hope for a breakthrough development of Russian science, bridging the technology gap, and ensuring a sustainable economic growth.

"Anyone who believes intelligence is concentrated in the head of a specific individual is grossly mistaken. In fact, intelligence exists not only in books, dictionaries and notebooks that we use but also in the heads of other people with whom we interact." [Bruner 2006] "Your chance of winning a Nobel Prize, interestingly, increases immeasurably if you have worked in a laboratory with somebody who has already won one, not just because of "stimulation" or "visibility", but because you have shared access to a richer distribution network" [Ibid.], argued Jerome Bruner, referring to other researchers. Science and technology parks, development programs from the leading research universities, and early engagement of students in lab research are designed to create such nutrient medium for talented students.

An integral learning and development system is necessary to bring gifted and interested students to the community of young promising physicists. Such system traditionally includes physico-mathematical schools, the Olympiad movement, and various creative science and technology competitions. Several doctoral theses are devoted to scientific justification of developing this system under the present-day conditions, which proves that the topic is truly relevant and demanded (Shompolov I. *Sistema vyyavleniya, podderzhki i razvitiya molodezhi, odarennoy v oblasti fiziki* [A Method of Identifying, Supporting and Developing Young Students Gifted in Physics] (Moscow Institute of Physics and Technology, 2003); Gurina R. *Podgotovka uchashchikhsya fiziko-matematicheskikh klassov k professionalnoy deyatelnosti v oblasti fiziki* [Preparing Students of Physico-Mathematical Classes to Careers in Physics] (Ulyanovsk State University, 2007); Ryzhikov S. *Razvitie issledovatelskikh sposobnostey odarennykh shkolnikov pri obuchenii fizike* [Developing Research Skills of Gifted School Students in Physics Class] (Moscow State Pedagogical University, 2015)).

Identifying talented school students and motivating them for an in-depth study of physics requires some research to determine the means of mass-scale student motivation and the prerequisites for enhancing the level of mass physics education. The relevance of such research is multiplied as physics courses are being largely cut at all levels of education. University physics is designed more and more to reinforce what was learned at school, while deeper learning is impeded by insufficient basic knowledge and skills possessed by yesterday's high school graduates [Gorokhovatsky et al. 2015; Kozhevnikov 2015].

The concerns about physics background of high school graduates and first-year students of different universities have already been reflected in thesis research (Danilyuk I. *Tekhnologiya razvivayushchego obucheniya v sisteme profilnoy podgotovki abiturientov tekhnicheskogo vuza po fizike* [Developmental Teaching Techniques in Specialty-Specific Physics Courses for Technical University Candidates] (Samara State Technical University, 2006); Vaganova T. *Modulno-kompetentnostnoe obuchenie fizike studentov mladshikh kursov tekhnicheskikh universitetov* [Module and Competency Based Physics Education for Underclassmen in Technical Universities] (Moscow State Pedagogical University, 2007); Starikova Y. *Adaptivnaya napravlennost metodiki obucheniya osnovam fiziki studentov meditsinskogo vuza* [Adaptive Technology in the Methods of Teaching Basic Physics in Medical Universities] (Chelyabinsk State Pedagogical University, 2009); Polonyankin D. *Metodika formirovaniya motivatsii uchebnoy deyatelnosti pri obuchenii fizike studentov mladshikh kursov* [Methods of Developing Motivation for Learning When Teaching Physics to Underclassmen] (Dostoyevsky Omsk State University, 2011), and others).

**4.4. What risks for physics education can be anticipated**

The envisaged changes to the physics learning approaches may result in some cognitive challenges for different categories of learners, school students particularly.

Physics as a school subject is considered to be difficult and thus barely attractive. This widespread belief has contributed a lot to shrinking the number of hours in the school physics course, despite its developmental potential. One of the reasons behind the decrease in motivation for learning physics is typical cognitive barriers and mistakes that are regularly faced by students, making them believe that the subject is too sophisticated. It becomes important to find ways of detecting such cognitive barriers at an early stage, identifying where they come from and how they can be surmounted or, better, prevented [Larchenkova 2013]. Even effective traditional methods have to be revised due to the fundamental transformations going on in the human mind today.

Too little attention is paid to the origins of students' cognitive barriers: we found only three works in the database analyzed (Rykov V. *Metodika korrektirovki bazovykh znaniy po fizike* [Methods of Correcting the Basic Knowledge of Physics] (Kuban State University, 2003); Yakovets Y. *Preodolenie matematicheskikh zatrudneniy uchashchikhsya pri obuchenii fizike v osnovnoy shkole* [Overcoming Mathematical Barriers of Students When Teaching Physics in Secondary School] (Moscow State Pedagogical University, 2007); Rogova I. *Metodika organizatsii raboty so slabouspevayushchimi uchenikami v protsesse obucheniya fizike* [Methodology of Dealing with Lagging Students When Teaching Physics] (Kurgan State University, 2008)). In practice, cognitive barriers are surmounted by trial and error, while theses only acknowledge the fact of their existence and describe spe-

cific problems of physics learners without trying to find their underlying causes.

At the level of secondary education, attempts to overcome such barriers are made using the differentiated approach to teaching physics, which includes creating specialized classes and grouping students based on their skills and abilities. However, while organization of physics courses for classes and schools of different types—specialized, mass, special—has been studied quite actively, much less attention is paid to cognitive barriers in learning physics. Meanwhile, they are regularly faced by all categories of students.

Talented school students may also experience some difficulties [Sheblanova 2003], so they should be helped to unlock and realize their full potential. Teaching such students should build upon their strong points and upon engaging them in activities that help them unleash their talent, provide them with immediate chances for successful realization of their capabilities and needs, and boost their ambition to overcome barriers.

Teaching children with disabilities, including those that cause developmental delay, is also of critical importance today. Such students go to special schools, many of which offer physics courses among others. Further socialization of special school graduates makes it vital to teach them all general education subjects: a standard secondary school background will enable them to enter a special vocational institution, learn a profession, and get a job. However, there is no information on teaching physics to special students in any of the textbooks, guidance materials, or recommendations available. Teachers are left to deal with cognitive problems of such students face to face and solve them using intuition and improvisation, with varying degrees of success. Neither did we find any thesis on teaching physics in special schools. This research avenue needs desperately to be developed in the context of the growing demand for inclusive education.

Thesis research has never addressed the risks associated with integrating information and communications technology into education. Degree seekers pay a lot of attention to the technology as such, but they mostly adjust it to the learning process, considering it an unconditional benefit. Meanwhile, there is the other side of the coin, too. For instance, the exponential growth of information, as well as its diversity and dialogue at different levels of the social system result in so-called "clip thinking", where people begin to perceive information as mosaic and fragmentary and lose their ability to analyze and build long logical chains. Obviously, it does not contribute to understanding physics. People with "clip thinking" develop good multitasking skills and the ability to switch very quickly between different sources and bulks of information. Is it good or bad? On the one hand, these qualities act as antagonists, since responsiveness develops through concentration, and vice versa. On the other hand, the need to perceive information in fragments as a defense reaction to information overload is not a new

phenomenon. Textbooks, reference books and encyclopedia are designed to be read in portions and allow readers to use specific parts of their content as needed. Even a physics problem as a teaching tool is in line with this thinking development trend, its setting representing a clip-like resume of a real-life situation.

Identifying the positive and negative effects of using information and communications technology in physics education will require a cross-disciplinary research and a concerted effort of researchers from different fields, including psychologists, physicists, methodologists, and IT experts.

Scientific justification is also required to underlie the development of physics teaching materials, i. e. textbooks, problem books, and supplementary guidebooks, to meet the requirements imposed by the modern level of basic science, the new instructional approaches, and the different ways in which information is perceived and processed by different categories of students. Although a good deal of physics textbooks has been created in the recent years, there has long been no research to be used as a basis for them. The problem is also pressing for higher education, where teaching aids tend to turn into look-up dictionaries, the methodological value of which falls dramatically due to information availability provided by the Internet [Kozhevnikov 2015]. In our database of theses, we managed to find only one devoted to comparative analysis of the existing physics textbooks for secondary school—Lezhepekova O. *Sravnitelny analiz ispolzovaniya sovremennykh uchebnikov fiziki v osnovnoy shkole* [A Comparative Analysis of Using Modern Physics Textbooks in Secondary School] (Vyatka State University of Humanities, 2009)—and none on digital textbooks. Meanwhile, the demand for e-textbooks is increasing, whereas no relevant requirements have been defined so far, and the whole process has been showing little progress.

## 5. Conclusion

An investigation into the topics of theses in specialty 13.00.02 "Theory and Methods of Teaching and Education (Physics, Secondary and Tertiary Education Levels)" defended for the last 16 years, the directions of physics development, and the needs of modern physics education allows us to draw the following conclusions.

- Physics education, which lays the foundation for a long-term development of science and technology, is designed to develop personal qualities important not only for doing research but also for living a successful everyday life of a 21st-century person.
- Due to the recent changes in the sociocultural context, various types of learners get more access to thesis research, which creates additional requirements to the relevance and novelty of topics.
- The range of thesis topics is unbalanced, with the least interest shown in such directions as design, testing and performance as-

sessment of physics syllabi of different types and levels, cognitive processes of physics learners, and development of physics teaching aids including textbooks.

· The desirable avenues of physics education development, which need to be supported by research (theses in particular), are closely interrelated. Such avenues include, first of all:

 – Upgrading the content of physics education to make it reflect not only the fundamental principles but also recent physics discoveries, selected and adapted for perception by various categories of learners;

 – Designing new nonlinear syllabi, textbooks, and learning kits to provide diversity and variation when teaching physics to different categories of students in educational institutions of different types;

 – Using new information technology in education not only as a means of illustration and learning process organization but also as a way of transforming the essential basics of teaching physics;

 – Ensuring cohesiveness and continuity of teaching physics across all levels of education and all categories of students.

 – While making no pretence to absolute completeness or finality of our recommendations, which would be inappropriate for a scientific inquiry, we nevertheless believe that the abovementioned research avenues could be defined as top priorities in the research on theory and methods of teaching physics for the foreseeable future.

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# How the Use of Internet and Multimedia Technology in Education Correlates with Student Engagement

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**Abstract.** This research was performed to investigate the correlations between the use of Internet and multimedia technology by university teachers and four styles of student engagement. The study was based on the data collected in 2015 from 11 universities (the total sample included 16,893 Bachelor's and Specialist's degree students) as part of the Trajectories and Experiences of Russian University Students Project. The findings support the hypothesis about a positive correlation between the use of Internet and multimedia technology, on the one hand, and student engagement in learning and interacting with teachers and peers, on the other hand. The more widely multimedia technology is used by teachers, the higher academic and social engagement of students and their commitment to meet teachers' high requirements is—and the lower their engagement in academic nonperformance is.

The widespread use of the Internet and multimedia technology observed today in many spheres could not leave university learning untouched. Some teachers use new technology opportunities to diversify the learning process and increase effectiveness. Besides, universities actively implement new education formats, such as learning management systems (LMS), online courses, blended learning, etc. Meanwhile, it remains unknown how the integration of the Internet and multimedia into learning affects student performance. Some researchers believe that digital technology in education can not only result in new practices that will be simple alternatives to existing ones, but also transform the very learning process significantly [Coates 2006], as learning tools influence thinking patterns [Turkle 2004]. In this article, we are trying to find out how the use of new technology

in education is associated with various aspects of university learning activities.

One of the trends in the research on the influence of new technology on university student performance is to study the effectiveness of PowerPoint-based lectures. In particular, Jennifer Clark shows that the use of PowerPoint presentations stimulates the interest of students in the information presented and boosts their attention by providing visual stimuli [Clark 2008]. However, this effect can only be achieved if the presentation is dynamic and uses different text formats and examples. In addition, the research on the influence of e-presentations on academic performance provides no unambiguous implications: some studies report positive effects [Reinhardt 1999; Parks 1999; Lowry 1999], while others do not [Szabo, Hastings 2000; Rankin, Hoaas 2001].

The abovementioned publications represent early studies conducted when e-presentations were first introduced in education. The practice has spread widely by now, and some researchers believe that PowerPoint presentations do not provide the same initial effect anymore. For instance, it was empirically proven that student assessment of PowerPoint presentations' influence on learning and peer interactions correlated with a perceived novelty of this way of presenting information [Burke, James 2008]. Perception of e-presentations may vary depending on the course and material delivered [Burke, James, Ahmadi 2009]. It is also affected by the speaker's appearance and manner of speaking [Farwell 2005]. Therefore, the mere act of using PowerPoint presentations does not boost engagement or academic performance, because the effects depend largely on how the format is used by a teacher. According to some researchers, searching for ways to convert the overall positive attitude of students toward presentations into improved learning and, hence, performance is a key pedagogical challenge [Craig, Amernic 2006].

Another avenue for research in this field is exploring the popularity and effectiveness of learning management systems (LMS). According to the 2006/07 statistics, over 90% of American universities [Hawkins, Rudy 2007] and 95% of British higher education institutions [Browne, Jenkins, Walker 2006] installed and provided LMS for use by teachers and students. However, active implementation of such systems requires that teachers not only develop LMS skills but also change their teaching habits to encourage students to use the system for learning and interacting with teachers [Topper 2003; Dougiamas, Taylor 2003; Bender 2005; Gaensler 2004]. A number of studies have shown that students and instructors assess their LMS experience as overall positive [Lonn, Teasley 2009; Naveh, Tubin, Pliskin 2010]. For instance, students report that LMS facilitate access to study materials [Lonn, Teasley 2009], making the learning process more flexible and less restricted to a specific time and/or place [Piccoli, Ahmad, Ives 2001]. Yet, not all students are able to benefit from using LMS, as it depends

on the way they implement the learning tools [Lust et al. 2012]. There are also studies showing that LMS are only considered effective by university administrators, while students and teachers perceive them as a barely useful supplement to the conventional teaching practices [Lai, Savage 2013]. Such findings may be the result of student and teacher resistance to innovations in education. On the whole, researchers tend to summarize that the use of LMS in education transforms considerably the traditional learning and teacher-student interaction patterns [Coates, James, Baldwin 2005; Coates 2006; Beer, Clark, Jones 2010], but there still has been no unambiguous data on how these transformations affect academic achievements and university experiences of students.

Some empirical studies also demonstrate that teachers can increase student engagement in learning not only by using ICT in the classroom but also by encouraging students to use the Internet and multimedia options. Based on the data obtained in the National Survey of Student Engagement (NSSE) conducted in the USA and Canada in 2003, researchers conclude that the use of IT by students for learning purposes correlates positively with their engagement and interaction with teachers [Laird, Kuh 2005]. Another study reveals that using Twitter for learning purposes has a positive effect on student engagement and GPA [Junco, Heiberger, Loken 2011].

Russian researchers address the effectiveness of using multimedia and Internet technology in education as part of pedagogical experiments, among other aspects. In particular, Zanozin refers to the results of assessing the effectiveness of e-learning packages in pedagogy and in the discipline called Teaching Techniques & Psychological Workshop. The students working with these electronic resources were found to score better in the final test than those who used printed materials [Zanozin 2011]. The multimedia packet developed for the year-long ecology course offered by Tomsk State University also proved more effective than the traditional teaching methods [Rudenko 2003]. Similar results were obtained in other Russian experimental studies, such as [Alexandrov 2009; Dmitriev 2011; Meshcheryakov, Dmitriev 2011].

Although many teachers and students assess positively the teaching and learning effects of information technology [Lonn, Teasley 2009], most instructors remain faithful to traditional formats of lectures and seminars. During the survey conducted under the Trajectories and Experiences of University Students in Russia project (we will dwell on it in the Data and Method chapter), only 22% of students reported that their teachers used LMS to deliver study materials and course-related information. Less than two-thirds of respondents agreed that most (or all) teachers used e-presentations in the classroom and a messaging platform to communicate with students, and only 39% indicated that many teachers used photo and video content for teaching purposes (Fig. 1).

Figure 1. **The use of the Internet and multimedia technology by teachers**,% (*N* = 16,893)
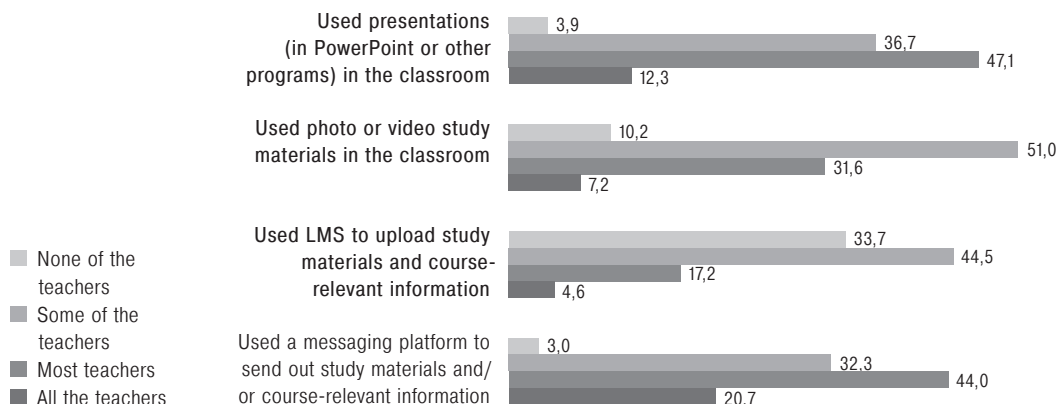


This paper investigates the influence that the use of new educational technology by teachers has on student engagement in Russia. According to the approach proposed by George D. Kuh [2007], we understand student engagement as involvement in effective educational practices. Using student engagement as an indicator of academic performance when exploring student learning activities has a number of advantages [Pascarella 2001, Ewell, Jones 1993; 1996]. By measuring student engagement, we can assess various aspects of the current learning situation. It has been established that engagement affects educational achievements, which proves that the relevant indicators are valid [Maloshonok 2014].

**Conceptual Framework**

To analyze the influence of using new educational technology by teachers on student engagement in the learning process, we rely upon the behavioral approach that formed the basis for the development of machine learning systems. According to Skinner and his ideas of operant conditioning, people and animals learn by running into contingencies that act as reinforcers [Skinner 1965]. The learning process is more intensive in educational environments, where teachers arrange special contingencies that expedite learning to hasten the appearance of certain behavior and increase learning effectiveness [Skinner 1963]. In machine learning, some contingencies of reinforcement may be provided by automated devices. Therefore, Skinner suggests that teachers can use special teaching machines to optimize the learning process [Skinner 1965]. Based on these theoretical assumptions, we can suggest that the use of multimedia and Internet technologies allows teachers to enrich and diversify their sets of reinforcement contingencies, boosting effectiveness of learning. The learning process transformations will be reflected in student behav-

ior as responses to the new stimuli, thus increasing student engagement. Now, we can formulate the research hypothesis as follows: the use of the Internet and multimedia technology in education correlates positively with student engagement. Consequently, the proposed hypothesis contradicts the following statements: "The use of technology by teachers has negative or no effects on student engagement since students respond to interactive tools in the same way they respond to conventional teaching practices", and "The use of digital technology in education distracts students from actually learning, decreasing their engagement".

**Data and Method**

The empirical basis of the research was provided by data from the interuniversity project Trajectories and Experiences of University Students in Russia, collected from 11 Russian universities. Ten of them are involved in the Project 5–100 (Kazan Federal University, Lobachevsky State University of Nizhny Novgorod, National Research University Higher School of Economics, Tomsk State University, Tomsk Polytechnic University, Samara State Aerospace University, Peter the Great St. Petersburg Polytechnic University, Saint Petersburg Electrotechnical University, ITMO University, and Ural Federal University), and one is a federal university (North-Eastern Federal University). Links to the online survey were sent out to students' emails in spring 2015. In some universities, the links were sent to students' personal LMS profiles. The response rate varied from 5% to 40% across the universities. The total sample used for analysis included 16,893 students. The different response rates in different universities was primarily to do with the commitment of project coordinators who were in charge of the field stage (advertizing, engaging students and providing additional incentives, such as a lottery, etc.). Besides, the response rate depended on the overall student attitude towards surveys and the level of the relevant culture in a specific university. Some students are used to filling out questionnaires, but it may be a new experience for others. Sample representativeness was assessed depending on the year of study and the form of financing[1]. The difference in the response rate depending on the form of financing varies from 0% to 18% across the universities, and the difference determined by the year of study ranges from 4% to 42.8%. As we can see, the resulting sample does not represent all Russian universities, and not all specific university samples represent the general university population. It is also probable that the sample is biased towards more engaged students with better academic outcomes (Table 1, Addendum).

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[1] These were the only two sample assessment parameters available, due to the limitations of statistical data collected by universities.

The use of the Internet and multimedia technology by teachers was assessed based on four indicators:

- Using presentations (in PowerPoint or other programs) in the classroom
- Using photo or video study materials in the classroom;
- Using LMS to upload study materials and course-relevant information;
- Using a messaging platform to send out study materials and/or course-relevant information.

The indicators were measured using a four-point rating scale: "None of the teachers", "Some of the teachers", "Most teachers', and "All the teachers" (Table 2, Addendum)

**Student engagement styles**

To assess student engagement, we used a number of indicators showing student involvement in various types of learning activities. To present the results in a convenient form, we grouped the abundance of indicators into four engagement styles using factor analysis (principal component analysis). Before shrinking the feature space to a few factors, we analyzed the validity and reliability of the indicators within each factor.

The factors analysis revealed the following student engagement styles[2].

1. *Academic engagement* (14 indicators, Cronbach's α = 0.904). This factor explains 44.74% of the variance of initial parameters and describes the degree of student involvement in classroom and extracurricular activities as well as in various types of intellectual activities during their university studies. This engagement style was assessed using the indicators measuring the frequency of students doing the following (factor loadings are given in brackets):
   - Participating in discussions and seminars (0.625)
   - Using ideas and concepts from different courses in classroom discussions (0.712)
   - Asking course-related questions in the classroom (0.619)

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[2] Within the framework of this study, we first performed an explanatory factor analysis to determine the approximate typology of engagement styles. Next, we tested the indicators within each factor for validity and reliability using Cronbach's alpha. The indicators that lowered the overall reliability level were removed from analysis. After that, we constructed a factor model with one predetermined factor for each engagement style. Further on, we used the factor value obtained as a result of this analysis.

– Being highly interested in the subject, i. e. working on it more than required (0.560)
– Delivering reports or presentations in the classroom (0.556)
– Analyzing specific facts, terms and concepts (0.642)
– Investigating the methods, ideas or concepts and using them to solve training problems (0.677)
– Analyzing the arguments and the implications derived from them (0.757)
– Evaluating information, ideas or implications based on the reliability of sources and the accuracy of methods and arguments (0.719)
– Putting forward new ideas, developments and approaches (0.655)
– Using facts and examples to justify one's point of view (0.760)
– Implementing ideas and concepts from different disciplines when doing homework (0.750)
– Analyzing the data collection and interpretation methods used by other people and assessing the soundness of their implications (0.682)
– Reconsidering one's opinion on a specific situation after assessing the arguments of other people (0.605).

2. *Social engagement* (6 indicators, Cronbach's α = 0.759). This factor explains 45.83% of the variance of initial parameters and describes the degree of student involvement in interactions with teachers and peers to achieve one's educational goals. This factor includes the indicators showing how often students engage in the following:
   – Interacting with teachers personally: face-to-face, by telephone or email (0.723)
   – Discussing course-related ideas or concepts with teachers out of class (0.802)
   – Working together with a teacher on social or creative extracurricular projects (e. g. student organizations, student governments, etc.) (0.674)
   – Asking a teacher, teacher's assistant or tutor for assistance when needed (0.617)
   – Working on a group task or team project with peers out of class (0.616)
   – Assisting one's peers when preparing for classes together (0.608).

3. *Engagement in academic nonperformance* (3 indicators, Cronbach's α = 0.776). This factor explains 69.57% of the variance of initial parameters measuring the frequency of committing the following violations:
   – Handing in tasks after the deadline has expired (0.811)

    – Coming unprepared to classes (0.877)
    – Skipping classes without good reason (0.813).

4. *Commitment to meet the teacher's high requirements* (2 indicators, Cronbach's α = 0.669). This factor explains 75.13% of the variance of initial parameters and describes the tendency of students to make every effort to meet the teacher's requirements. The factor was calculated by measuring the frequency of students doing the following:
    – Making more effort than usual to succeed in the course due to the high requirements imposed by the teacher (0.867)
    – Redoing written work fundamentally at least once before handing it in (0.867).

The factors constructed correlate moderately with one another: the Pearson correlation coefficients are given in Table 3 of the Addendum.

**Regression analysis results**

Multiple linear regression analysis was used to identify correlations between the use of digital technology by teachers and student engagement in learning. Student engagement styles acted as dependent variables and the four indicators of the use of multimedia and Internet technology represented independent variables. Three regression models were constructed for each of the four engagement styles. Model 1 included only the dependent variable (manifestation of a specific engagement style) and four independent variables as predictors. Similarly, Model 2 included the dependent and four independent variables but also the following control variables: gender, form of financing, field and year of study. Model 3, apart from the control variables mentioned above, also included variables showing which university students study at. The choice of control variables is explained by the fact that student engagement and learning activity normally depend on both individual characteristics (gender, having a public-funded place or not, year of study) as well as disciplinary (field of study) and institutional university-associated factors. The correlation coefficients for the dependent variables in the regression are given in Table 4 of the Addendum.

While constructing each regression model, we used Variance Inflation Factors (VIF) to measure how much multicollinearity inflated the variance of the estimated regression coefficients. VIF varied from 1.129 to 1.533 for all the considered predictors in all the models constructed, which means that all of the predictors were safe to use.

The regression models constructed for the "academic engagement" dependent variable show that all the four indicators of the use of digital technology in education correlate positively with academic engagement (Table 1). Using photo and video study materials in the classroom and using a messaging platform to interact with students appear to be the most powerful factors. As we add the control varia-

Table 1. **Regression coefficients for the model with academic engagement as the dependent variable**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance |
| Constant | | 0.000 | | 0.000 | | 0.813 |
| Predictors | | | | | | |
| Used presentations (in PowerPoint or other programs) in the classroom | 0.076 | 0.000 | 0.057 | 0.000 | 0.050 | 0.000 |
| Used photo or video study materials in the classroom | 0.112 | 0.000 | 0.127 | 0.000 | 0.129 | 0.000 |
| Used LMS to upload study materials and course-relevant information | 0.02 | 0.000 | 0.022 | 0.008 | 0.045 | 0.000 |
| Used a messaging platform to send out study materials and/or course-relevant information | 0.148 | 0.018 | 0.134 | 0.000 | 0.079 | 0.000 |
| Control variables | | | | | | |
| Gender (male) | — | — | −0.027 | 0.002 | −0.025 | 0.002 |
| Form of financing (public-funded) | — | — | 0.077 | 0.000 | 0.095 | 0.000 |
| Field of study (exact sciences) | — | — | 0.024 | 0.006 | −0.019 | 0.035 |
| Field of study (engineering) | — | — | −0.071 | 0.000 | −0.158 | 0.000 |
| Field of study (social sciences) | — | — | 0.118 | 0.000 | 0.043 | 0.000 |
| Year of study | — | — | −0.024 | 0.003 | 0.003 | 0.685 |
| University 1 | — | — | — | — | −0.008 | 0.525 |
| University 2 | — | — | — | — | −0.094 | 0.000 |
| University 3 | — | — | — | — | −0.046 | 0.000 |
| University 4 | — | — | — | — | −0.020 | 0.067 |
| University 5 | — | — | — | — | −0.077 | 0.000 |
| University 6 | — | — | — | — | −0.313 | 0.000 |
| University 7 | — | — | — | — | −0.064 | 0.000 |
| University 8 | — | — | — | — | −0.074 | 0.000 |
| University 9 | — | — | — | — | −0.068 | 0.000 |
| University 10 | — | — | — | — | −0.019 | 0.061 |

*Note:* Dependent variable: academic engagement (factor value). Independent variables take on "1" if a respondent opts for "Most teachers" or "All the teachers" and "0" if he/she opts for "None of the teachers" or "Some of the teachers". Model 1: $R^2 = 0.069$, adjusted $R^2 = 0.068$, standard error of the estimate = 0.965, Durbin–Watson statistic = 1.779. Model 2: $R^2 = 0.097$, adjusted $R^2 = 0.096$, standard error of the estimate = 0.951, Durbin–Watson statistic = 1.808. Model 3: $R^2 = 0.153$, adjusted $R^2 = 0.152$, standard error of the estimate = 0.921, Durbin–Watson statistic = 1.946.

bles to the analysis, the adjusted $R^2$ grows from 0.068 to 0.153. Consequently, the indicators of the use of multimedia technology only explain a small proportion of academic engagement variance. However, the statistically significant regression coefficients observed in all three cases prove that there is a positive relationship between the variables, i.e. our hypothesis is confirmed.

The regression model constructed for the "social engagement" dependent variable also reveals a significant correlation between all the indicators of the use of multimedia technology and the factor manifestation, whether the control variables are included or not (Table 2). Based on the results obtained, we can assume that the more often technology is used in education, the more students involve themselves in interactions with teachers and peers to achieve their educational goals. Adding the control variables to the model increases the adjusted $R^2$, which the percentage of variance explained by the model, from 0.090 to 0.120. The low percentage of explained variance indicates that social engagement is mostly provided by other factors not included in the model. Nevertheless, the analysis results demonstrate a correlation between the use of multimedia technology by teachers and social engagement of students, thus confirming our hypothesis.

The following three regression models were constructed for the "engagement in academic nonperformance" dependent variable (Table 3). Analysis reveals significant negative correlations between the factor value and the two indicators: using photo and video study materials in the classroom and using LMS to upload study materials and course-relevant information—in all three models. Models 1 and 3 also demonstrate a significant negative correlation between using presentations and engagement in academic nonperformance. Therefore, using photo and video materials and LMS may contribute to decreasing the incidence of students violating deadlines, missing classes or coming unprepared to the classroom. Meanwhile, the indicators of the use of multimedia technology by teachers explain very little the manifestation of the nonperformance factor, as evidenced by $R^2$ and its growth from 0.005 to 0.059 after adding the control variables.

The last three regression models were constructed for the "commitment to meet teacher's high requirements" dependent variable (Table 4). As in the first two cases, the factor value correlates positively with all the indicators defined as predictors in all the models with the control variables included or not. Based on this observation, we can conclude that the active use of PowerPoint presentations, photo and video study materials, LMS, and a messaging platform to interact with students correlates positively with the effort that students make to perform better in order to meet the high requirements imposed by teachers. The adjusted $R^2$ grows insignificantly from 0.016 to 0.052 when the control variables are added, so the variance of this student engagement factor is only explained by the revealed correlations to a small extent.

Table 2. **Regression coefficients for the model with social engagement as the dependent variable**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance |
| Constant | | 0.000 | | 0.000 | | 0.000 |
| Predictors | | | | | | |
| Used presentations (in PowerPoint or other programs) in the classroom | 0.048 | 0.000 | 0.040 | 0.000 | 0.037 | 0.000 |
| Used photo or video study materials in the classroom | 0.146 | 0.000 | 0.137 | 0.000 | 0.139 | 0.000 |
| Used LMS to upload study materials and course-relevant information | 0.101 | 0.000 | 0.108 | 0.000 | 0.117 | 0.000 |
| Used a messaging platform to send out study materials and/or course-relevant information | 0.130 | 0.000 | 0.130 | 0.000 | 0.101 | 0.000 |
| Control variables | | | | | | |
| Gender (male) | — | — | −0.025 | 0.002 | −0.029 | 0.000 |
| Form of financing (public-funded) | — | — | 0.056 | 0.000 | 0.057 | 0.000 |
| Field of study (exact sciences) | — | — | −0.020 | 0.017 | −0.026 | 0.004 |
| Field of study (engineering) | — | — | −0.021 | 0.042 | −0.063 | 0.000 |
| Field of study (social sciences) | — | — | −0.010 | 0.293 | −0.033 | 0.002 |
| Year of study | — | — | 0.110 | 0.000 | 0.118 | 0.000 |
| University 1 | — | — | — | — | 0.038 | 0.002 |
| University 2 | — | — | — | — | −0.049 | 0.000 |
| University 3 | — | — | — | — | −0.031 | 0.000 |
| University 4 | — | — | — | — | 0.018 | 0.100 |
| University 5 | — | — | — | — | −0.003 | 0.780 |
| University 6 | — | — | — | — | −0.100 | 0.000 |
| University 7 | — | — | — | — | −0.014 | 0.130 |
| University 8 | — | — | — | — | −0.048 | 0.000 |
| University 9 | — | — | — | — | −0.030 | 0.007 |
| University 10 | — | — | — | — | 0.007 | 0.455 |

Note: Dependent variable: social engagement (factor value). Independent variables take on "1" if a respondent opts for "Most teachers" or "All the teachers" and "0" if he/she opts for "None of the teachers" or "Some of the teachers". Model 1: $R^2 = 0.090$, adjusted $R^2 = 0.090$, standard error of the estimate = 0.954, Durbin–Watson statistic = 1.866. Model 2: $R^2 = 0.107$, adjusted $R^2 = 0.106$, standard error of the estimate = 0.945, Durbin–Watson statistic = 1.843. Model 3: $R^2 = 0.120$, adjusted $R^2 = 0.119$, standard error of the estimate = 0.939, Durbin–Watson statistic = 1.901.

Table 3. **Regression coefficients for the model with engagement in academic nonperformance as the dependent variable**

|  | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
|  | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance |
| Constant | | 0.000 | | 0.025 | | 0.000 |
| Predictors | | | | | | |
| Used presentations (in PowerPoint or other programs) in the classroom | −0.032 | 0.001 | −0.012 | 0.199 | −0.021 | 0.025 |
| Used photo or video study materials in the classroom | −0.042 | 0.000 | −0.040 | 0.000 | −0.033 | 0.000 |
| Used LMS to upload study materials and course-relevant information | −0.022 | 0.007 | −0.026 | 0.002 | −0.027 | 0.001 |
| Used a messaging platform to send out study materials and/or course-relevant information | 0.010 | 0.224 | 0.015 | 0.064 | 0.012 | 0.157 |
| Control variables | | | | | | |
| Gender (male) | — | — | 0.170 | 0.000 | 0.168 | 0.000 |
| Form of financing (public-funded) | — | — | −0.042 | 0.000 | −0.052 | 0.000 |
| Field of study (exact sciences) | — | — | 0.051 | 0.000 | 0.043 | 0.000 |
| Field of study (engineering) | — | — | 0.034 | 0.001 | 0.01 | 0.406 |
| Field of study (social sciences) | — | — | 0.012 | 0.232 | −0.017 | 0.117 |
| Year of study | — | — | −0.013 | 0.100 | −0.001 | 0.897 |
| University 1 | — | — | — | — | 0.098 | 0.000 |
| University 2 | — | — | — | — | 0.118 | 0.000 |
| University 3 | — | — | — | — | 0.014 | 0.124 |
| University 4 | — | — | — | — | 0.155 | 0.000 |
| University 5 | — | — | — | — | 0.158 | 0.000 |
| University 6 | — | — | — | — | 0.139 | 0.000 |
| University 7 | — | — | — | — | 0.056 | 0.000 |
| University 8 | — | — | — | — | 0.117 | 0.000 |
| University 9 | — | — | — | — | 0.138 | 0.000 |
| University 10 | — | — | — | — | 0.068 | 0.000 |

*Note:* Dependent variable: engagement in academic nonperformance (factor value). Independent variables take on "1" if a respondent opts for "Most teachers" or "All the teachers" and "0" if he/she opts for "None of the teachers" or "Some of the teachers". Model 1: $R^2 = 0.005$, adjusted $R^2 = 0.005$, standard error of the estimate = 0.997, Durbin–Watson statistic = 1.854. Model 2: $R^2 = 0.040$, adjusted $R^2 = 0.039$, standard error of the estimate = 0.980, Durbin–Watson statistic = 1.920. Model 3: $R^2 = 0.059$, adjusted $R^2 = 0.058$, standard error of the estimate = 0.971, Durbin–Watson statistic = 1.958

Table 4. **Regression coefficients for the model with commitment to meet the teacher's high requirements as the dependent variable**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance | Standard-ized (Beta) coefficient | Signifi-cance |
| Constant | | 0.000 | | 0.055 | | 0.000 |
| Predictors | | | | | | |
| Used presentations (in PowerPoint or other programs) in the classroom | 0.023 | 0.014 | 0.021 | 0.027 | 0.027 | 0.004 |
| Used photo or video study materials in the classroom | 0.052 | 0.000 | 0.059 | 0.000 | 0.057 | 0.000 |
| Used LMS to upload study materials and course-relevant information | 0.042 | 0.000 | 0.038 | 0.000 | 0.052 | 0.000 |
| Used a messaging platform to send out study materials and/or course-relevant information | 0.065 | 0.000 | 0.065 | 0.000 | 0.040 | 0.000 |
| Control variables | | | | | | |
| Gender (male) | — | — | −0.114 | 0.000 | −0.113 | 0.000 |
| Form of financing (public-funded) | — | — | −0.002 | 0.799 | 0.016 | 0.058 |
| Field of study (exact sciences) | — | — | 0.012 | 0.158 | −0.009 | 0.320 |
| Field of study (engineering) | — | — | 0.044 | 0.000 | −0.012 | 0.294 |
| Field of study (social sciences) | — | — | 0.002 | 0.874 | −0.019 | 0.080 |
| Year of study | — | — | −0.090 | 0.000 | −0.082 | 0.000 |
| University 1 | — | — | — | — | 0.015 | 0.229 |
| University 2 | — | — | — | — | −0.053 | 0.000 |
| University 3 | — | — | — | — | −0.029 | 0.001 |
| University 4 | — | — | — | — | −0.063 | 0.000 |
| University 5 | — | — | — | — | −0.060 | 0.000 |
| University 6 | — | — | — | — | −0.160 | 0.000 |
| University 7 | — | — | — | — | 0.002 | 0.807 |
| University 8 | — | — | — | — | −0.059 | 0.000 |
| University 9 | — | — | — | — | −0.014 | 0.206 |
| University 10 | — | — | — | — | −0.010 | 0.341 |

Note: Dependent variable: commitment to meet teacher's high requirements (factor value). Independent variables take on "1" if a respondent opts for "Most teachers" or "All the teachers" and "0" if he/she opts for "None of the teachers" or "Some of the teachers". Model 1: $R^2 = 0.016$, adjusted $R^2 = 0.016$, standard error of the estimate = 0.992, Durbin–Watson statistic = 1.905. Model 2: $R^2 = 0.036$, adjusted $R^2 = 0.035$, standard error of the estimate = 0.982, Durbin–Watson statistic = 1.916. Model 3: $R^2 = 0.054$, adjusted $R^2 = 0.052$, standard error of the estimate = 0.973, Durbin–Watson statistic = 1.968

**Discussion**  Based on the results above, we can assert that our hypothesis on the positive correlation between the use of multimedia and Internet technology by teachers and student engagement in learning and interacting with teachers and peers has been confirmed. Although we assume within our theoretical conception that using multimedia technology affects student behavior, the analysis we performed does not allow us to judge on the cause-effect relationship between these two phenomena. This limitation has to do with the study's empirical design: data was collected via surveys, and respondents' self-reports served as the basis for measuring the use of multimedia technology and student engagement. Nevertheless, the results we obtained can be used in universities' educational policies. In particular, universities should encourage teachers to use multimedia technology in education more actively. The intensity and effectiveness of integrating new technology into teaching practices are primarily determined by the teacher's belief that this technology has an educational value and will improve academic performance [Choudrie, Dwivedi 2005; Cushman, Klecun 2006; Frank et al. 2004; Mooij, Smee 2001; Ottenbreit-Leftwich et al. 2010]. This belief is an important factor in the use of multimedia technology [Mahdizadeh, Biemans, Mulder 2008; Miller et al. 2003]. Thus, to promote the use of advanced technologies, universities should spread information about their positive effects on learning and provide organizational support to teachers by training them to use multimedia technology and implement it in their teaching practices [Keengwe, Kidd, Kyei-Blankan 2009]. Attention should also be paid to a university's academic culture, which is a key prerequisite for accepting and integrating new technology into the learning process [Ferreira 2012].

Although we succeeded in confirming our hypothesis and the correlations between the use of multimedia technology and different styles of student engagement, there is no reason to believe that an essential increase in the percentage of teachers using the web and media opportunities in education will boost student engagement. The regression models constructed and the indicators of the use of advanced technology by teachers only explain a small proportion of student engagement variance. There may also be other variables having a greater impact on student engagement than the use of multimedia technology by teachers. Overall, we can say that these are preliminary findings which may be developed and upgraded during further research.

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**Addendum. Descriptive statistics for the variables used in analysis**

Table 1. **Distribution of respondents by gender, form of financing, year of study, and university**

|  | Sample proportion (%) |
|---|---|
| Gender: | |
| Male | 41.1 |
| Female | 58.9 |
| Form of financing: | |
| Public-funded | 73 |
| Tuition fees | 21.7 |
| Employer-sponsored | 5.3 |
| Year of study: | |
| 1st | 29.8 |
| 2ns | 25.6 |

|  | Sample proportion (%) |
|---|---|
| 3rd | 20.9 |
| 4th | 16.6 |
| 5th | 7.1 |
| Universities |  |
| University 1 | 11.3 |
| University 2 | 6.6 |
| University 3 | 2.4 |
| University 4 | 7.8 |
| University 5 | 9.8 |
| University 6 | 27.4 |
| University 7 | 3.3 |
| University 8 | 11.9 |
| University 9 | 8.6 |
| University 10 | 4.6 |
| University 11 | 6.3 |

Table 2. **Distribution of respondents' assessments of the use of multimedia technology by teachers**

|  | Answer selected | |
|---|---|---|
|  | "Most teachers" or "All the teachers" (%) | "None of the teachers" or "Some of the teachers" (%) |
| Used presentations (in Power-Point or other programs) in the classroom | 57.9 | 42.1 |
| Used photo or video study materials in the classroom | 37.7 | 62.3 |
| Used LMS to upload study materials and course-relevant information | 18.3 | 81.7 |
| Used a messaging platform to send out study materials and/or course-relevant information | 62.6 | 37.4 |

Table 3. **Correlation coefficients for the four styles of student engagement**

| | Academic engagement | Social engagement | Engagement in academic nonperformance | Commitment to meet teacher's high requirements |
|---|---|---|---|---|
| Academic engagement | 1 | 0,581*** | −0,175*** | 0,462*** |
| Social engagement | 0,581*** | 1 | −0,122*** | 0,439*** |
| Engagement in academic nonperformance | −0,175*** | −0,122*** | 1 | −0,107*** |
| Commitment to meet teacher's high require-ments | 0,462*** | 0,439*** | −0,107*** | 1 |

*Note:* *** indicates that correlation is significant at confidence level p<0.001

Table 4. **Correlation coefficients for the regression variables**

| | Used presentations (in PowerPoint or other programs) in the classroom | Used photo or video study materials in the classroom | Used LMS to upload study materials and course-relevant information | Used a messaging platform to send out study materials and/or course-relevant information |
|---|---|---|---|---|
| Used presentations (in PowerPoint or other programs) in the classroom | 1.000 | 0.529** | 0.268** | 0.291** |
| Used photo or video study materials in the classroom | 0.529** | 1.000 | 0.346** | 0.271** |
| Used LMS to upload study materials and course-relevant information | 0.268** | 0.346** | 1.000 | 0.228** |
| Used a messaging platform to send out study materials and/or course-relevant information | 0.291** | 0.271** | 0.228** | 1.000 |

Note: ** indicates that correlation is significant at confidence level p<0.01

# School Readiness of First-Graders and Associated Factors:

## Identifying Region-Specific Characteristics

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**Abstract.** The regions of Russia enjoy substantial autonomy in shaping their own education systems. However, there is very little objective empirical data on specific features of the development, for instance, of preschool and elementary school children in the regions. This situation renders it difficult to make informed decisions on any corrections required to meet region-specific needs. We analyzed the basic mathematical and reading skills of preschoolers in two regional capitals—Krasnoyarsk and Kazan. We applied the IPIPS study, which allows for assessing the skills of children starting school, to a sample of about 2,750 first-graders in the two cities. As we found out, the level of basic mathematical and reading skills correlated most strongly with such factors as sociocultural capital, early childhood education experience, and language spoken at home. Meanwhile, location in a specific region had virtually no impact on the skills analyzed.

**Keywords:** elementary education, school readiness, mathematical competencies, reading skills, regional differences, sociocultural capital, early childhood education experience.

There are a number of reasons for addressing the problem of assessing the skills of children starting school. First, the accelerating pace of social life brings substantial changes to the psychophysiological and personality development of children. It is impossible to make well-con-

sidered adjustments to the curriculum and the learning process without knowing the mechanisms of first-grader development. Second, the idea of lifelong learning requires that special attention be paid to providing continuity of preschool and elementary education, which means obtaining objective data on child development in the transitional period. Third, according to the Federal State Standard of Elementary Education, the achievement assessment system should be designed to allow the assessment of performance dynamics, which means that starting-level diagnostic tests are needed. Fourth, the regions of Russia now enjoy substantial autonomy in shaping their own education systems, yet there is extremely little objective data on the specific features of development of preschool and elementary school children in the regions, which makes it difficult to consider local peculiarities while modernizing the education systems.

There are few studies devoted to specific features of present-day Russian first-graders' educational needs, psychophysiological and personality development. The lack of such works and the grave problems that existent works do detect, which complicate the process of orientation, present another reason for investigating the level and nature of child development at the elementary school admission age.

Feldshteyn [2010] provides evidence of the adverse changes in recent decades: a decreased level of preschool cognitive development (creativity, ability to keep the problem statement in mind, and conceptual thinking), lower enthusiasm, excessive emotional discomfort, and low social competence.

A large-scale survey was conducted by the Center for Evaluating the Quality of Education, Institute for Strategy of Education Development, Russian Academy of Sciences [Kovaleva et al. 2011]. Two types of indicators were used: indicators of first-graders' readiness for school and contextual indicators related to individual characteristics of students, specific features of the learning process, school and class peculiarities, and family characteristics. Findings show that 15–20% of first-graders have no adequate background for learning.

In this paper, we assess the levels of basic mathematical and reading skills of first-graders in two regional capitals—Krasnoyarsk and Kazan. The study seeks to answer the following questions:

- What is the development level that first-graders bring to school?
- What are the factors affecting a child's performance at an early stage in school?
- Are there any regional disparities in the level of school readiness and, if so, how do they manifest themselves?

**1. International research on academic achievements of school applicants**

We relied on the international research experience to identify the factors that would be good to analyze in terms of their relationship with school readiness.

Some countries carry out national monitoring or longitudinal projects to assess the academic achievements of senior preschoolers and elementary school children. For instance, the Netherlands National Institute for Educational Measurement (CITO) has developed an elementary school assessment and monitoring system to consistently measure the level of skills and competencies in a wide range of subject-related and universal domains in children aged 4–12 [Timmermans et al. 2015]. Great Britain's Effective Pre-School, Primary & Secondary Education (EPPSE) project (now closed) studied the influence of family background, homeschooling and preschool experience on the academic achievements of first-graders [Sylva et al. 2010]. International Performance Indicators in Primary School (IPIPS), another major British project, assesses the skills of children starting school and their progress during the first year. We will dwell on this later in this article.

Elementary education has been a subject of interest for politicians and researchers across the world for many years. One way or another, all countries face growing educational inequality driven by the most diverse factors, whether it be capabilities, gender stereotypes, age characteristics, socioeconomic status, cultural differences, or geographical environment [Dee 2015; Hanushek 2013].

Gender differences in academic performance have been the focus of researchers' attention for a few decades [Maccoby, Jacklin 1974; Cornwell, Mustard, van Parys 2013]. For example, Dutch studies on elementary education found no significant discrepancy between boys and girls in mathematical and language proficiency. However, the position of boys in terms of educational level and attitudes and behavior was found to be much more unfavorable than that of girls [Driessen, van Langen 2013]. American researchers revealed that mathematics performance gaps favoring boys appeared soon after children began kindergarten and then widened during elementary grades [Robinson, Lubienski 2011]. Russian researchers have also received evidence of the need for educational techniques considering gender differences at early stages in learning [Buzhigeeva 2002].

Cognitive competencies can also be affected by such factors as socioeconomic status, language spoken at home, and ethnicity at the earliest stage of education. A huge amount of Western studies have been devoted to ethnic differences in academic achievement, whether it be the ethnic issues in the US [Gregory, Skiba, Noguera 2010] or the educational achievement gaps between immigrant and native students in the EU [Azzolini, Schnell, Palmer 2012].

Family characteristics often impact children's academic success [Morrissey, Hutchison, Winsler 2014]. Thus, a longitudinal project examined the influence of socioeconomic status and race on academic achievement in American kindergartens and first grade [Nesbitt, Baker-Ward, Willoughby 2013]. The researchers once again proved

Pierre Bourdieu's theory, demonstrating that both low income and ethnic minority status had negative effects on reading and math achievement. Similar findings were reported in a study on educational achievement at age 7–11 in England [Strand 2014]. Associations between the academic performance of school students and family characteristics, primarily socioeconomic status, have also been confirmed by Russian researchers [Tyumeneva 2008].

The role of parents in their children's education has been brought to the fore by researchers of educational achievement factors in recent years [Polivanova et al. 2015]. Parental involvement is measured by investment in extracurricular activities, active participation in children's learning and development, and interactions with teachers. As a rule, positive parental practices correlate positively with academic success [Driessen, Smit, Sleegers 2005; Phillipson 2010].

Academic performance at school is also associated with early childhood education experience. While some children can benefit from the availability of a kindergarten or child development centers, others may lag behind due to their inability to attend preschool education institutions [Buckrop, Roberts, Lo Casale-Crouch 2016]. Cross-regional differences in the engagement of children in preschool education, and the reasons behind them, have become the subject of dedicated research in Russia [Seliverstova 2008].

Cross-cultural comparative studies help to collect information on the factors that determine academic success in different contexts and analyze the best teaching and learning practices as well as the advantages and drawbacks of various educational systems. Russia participates in the TIMMS (Trends in International Mathematics and Science Study) and PIRLS (Progress in International Reading Literacy Study) on a regular basis [Martin, Mullis 2013]. However, comparative studies in education are not confined to international projects. Many countries conduct cross-regional research studies on the school performance of children [Tomul, Çelik 2009, Danhier, Martin 2014]. Our study is devoted to the region-specific features of early childhood education in the Russian context.

## 2. Regional elementary education systems

### 2.1. Kazan elementary education system

Tatarstan features a unique combination of traditions, religious beliefs and value orientations of its people. The Republic is home to 107 ethnicities, but the majority of the population consists of Tatars (53.2%) and Russians (39.7%). Tatars are the second largest ethnic group in Russia (after Russians)[1]. Although Tatarstan is a secular republic, the proportion of the religious population is much higher in this region than the national average. According to the Atlas of Religions and Eth-

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[1] Russian Statistical Yearbook. 2014. http://www.gks.ru/bgd/regl/b14_13/IsSWWW.exe/Stg/d01/04–12.htm

nicities of Russia, a survey conducted by Sreda Research Service in 2012, about 32% of Tatarstan's population are Muslims, while around 30% identify themselves as Orthodox[2].

The network of schools in Kazan, the capital of the Republic, is represented by 168 institutions teaching 109,105 children, including 10,317 in high school, 50,861 in middle school, and 47,927 in primary school. In addition, there are 51 preschool education institutions attended by 70,967 children.

The lack of places in preschool institutions is one of the main preschool education problems in Kazan, and which is not dissimilar to other large Russian cities. Only about 69% of preschoolers are covered with some type of educational services in public institutions. As of January 1, 2015, 44,623 children were on the waitlist for Kazan's preschools.

**2.2. Krasnoyarsk elementary education system**

Krasnoyarsk Krai is one of the largest regions of Russia, having the second largest area in the country. Just like Tatarstan, Krasnoyarsk Krai is a multinational region, yet Russians account for 90% of its population[3].

According to Krasnoyarsk Department of Education[4], in 2015 the network of schools included 126 institutions attended by 90,171 students, including 39,683 in primary school, 39,740 in middle school, and 10,748 in high school. The design capacity of schools is exceeded by 10%.

Krasnoyarsk has 19 preschool education institutions, attended by 22,972 children, which also suffer from a lack of places. About 60% of preschoolers receive educational services in public institutions. As of January 1, 2015, 45,691 children (including 4,857 aged 3–7) were on the waitlist for Krasnoyarsk's preschools.

**3. Research design**
**3.1. Sample**

Representative stratified random samples were drawn from the population of all first-graders in Kazan and Krasnoyarsk enrolled in 2014, separately for each city. The stratification was based on school status (regular school or advanced school, such as lyceum or gymnasium) and location (city district). Table 1 presents sampling data for Kazan and Krasnoyarsk districts, and Table 2 shows status-based school distribution.

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[2] http://sreda.org/ru/arena-news/tataryi-v-rossii-musulmane-selskie-zhiteli-schastlivyie-i-religioznyie

[3] Russian Statistical Yearbook. 2014. http://www.gks.ru/bgd/regl/b14_13/IsSWWW.exe/Stg/d01/04–12.htm

[4] Krasnoyarsk Krai General Education System. Education in Krasnoyarsk Krai: http://krao.ru/rb-topic_t_43.htm

Table 1. **Sampling in the districts of Kazan and Krasnoyarsk**

|  | Krasnoyarsk | Kazan |
|---|---|---|
| Districts in the city | 6 | 7 |
| Children population | 11,200 | 10,301 |
| Children in the sample | 1,438 | 1,303 |
| Classes in the sample | 63 | 54 |

Table 2. **Status-based school distribution**

|  | Population | | | | Sample | | | |
|---|---|---|---|---|---|---|---|---|
|  | Krasnoyarsk | | Kazan | | Krasnoyarsk | | Kazan | |
| Type of school | Number | Proportion | Number | Proportion | Number | Proportion | Number | Proportion |
| Regular school | 84 | 70% | 75 | 53% | 15 | 63% | 18 | 48% |
| Advanced school | 37 | 30% | 66 | 47% | 12 | 37% | 16 | 53% |
| TOTAL | 121 | 100% | 141 | 100% | 27 | 100% | 34 | 100% |

**3.2. Assessment tools**

Diagnostic tests on the Kazan and Krasnoyarsk first-graders were performed using the IPIPS (international Performance Indicators in Primary School), an assessment tool developed by Durham University (UK) to assess the skills of children starting school and their progress during the first year [Tymms 1999]. Tool adaptation and testing in Russia was provided by the Institute of Education under the National Research University Higher School of Economics (NRU HSE) [Ivanova, Nisskaya 2015].

IPIPS allows for assessing the starting mathematical and reading skills of school applicants and their academic progress in these two key areas during the first year. The tool also includes a parent questionnaire to obtain contextual information on preschool life and the development of children, family characteristics, and educational practices used by parents.

The mathematics module includes counting, simple sums using pictures, digit identification, number manipulations, and more difficult math problems. The reading module consists of tasks assessing the ability to understand text structure, acquaintance with letters, visual perception of words, and reading comprehension skills.

Mathematical processing of starting test scores yields 100-point scales for reading and mathematics.

**3.3. Findings**

Table 3 shows the average mathematics and reading scores of school children in the two regions, indicating the average age of the first-graders.

Table 3. **Children's scores and age**

| Indicators | Krasnoyarsk | | Kazan | |
|---|---|---|---|---|
| | Average score | Standard deviation | Average score | Standard deviation |
| Mathematics | 50.35 | 9.86 | 49.62 | 10.14 |
| Reading | 49.96 | 10.68 | 50.04 | 9.19 |
| Age (years) | 7.39 | | 7.32 | |

Table 4. **Variables for regression analysis**

| Variable | Description |
|---|---|
| Dependent variable | Score in mathematics, 2) Score in reading |
| Independent variables | |
| Region | Krasnoyarsk = 1, Kazan = 0 |
| School status | Gymnasium/lyceum/specialized school = 1, regular school = 0 |
| Sex | Female = 1, male = 0 |
| Age | Age in years |
| Kindergarten | Attended a kindergarten before school = 1, never attended a kindergarten = 0 |
| Mother's education | Higher education = 1, no completed higher education = 0 |
| Financial standing | Above-average/good financial standing = 1, other = 0 |
| Books 25 | No books/less than 25 books = 1, other = 0, reference category: 25–100 books |
| Books 100 | Big home library (100 or more books) = 1; less than 100 books = 0 |
| Language spoken at home | Russian = 1, other = 0 |
| Formal preschool courses | Attended formal preschool courses during the previous year = 1, attended no formal preschool courses = 0 |

**3.4. Variables for linear regression analysis**

We used linear regression analysis to identify the factors associated with the basic mathematical and reading skills of children starting school and to assess cross-regional differences in students' scores. First-graders' starting scores in mathematics and reading were used as dependent variables. Analysis included the following independent variables: region, school status, student's sex and age, mother's education, financial standing, language spoken at home, early childhood education experience, and number of books at home (Table 4).

The regression model with multiple variables can be presented in the following equation:

(1) $Y_i - \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_i,$

where $Y_i$ is a dependent variable describing first-graders' scores in mathematics or reading; $X_i$, $i = 1, \ldots, k$ are independent variables; $\beta_0$ is a constant; $\beta_i$ shows the regression coefficient of the $i$-th independent variable; and $\varepsilon$ is standard error.

As we can see, the linear regression analysis allows us to find out how a change by one point in an independent variable is reflected in the dependent variable, as well as the size and sign (positive or negative) of such regression coefficient.

In this research, we constructed 10 regression models with scores in mathematics or reading as dependent variables.

**3.5. Descriptive statistics of the key analysis variables**

Table 5 demonstrates the initial descriptive statistics on the key variables used in analysis. The socioeconomic status of first-graders' families, assessed by such indicators as the number of books at home, financial standing and parental education, is quite similar between the two regional capitals. In both cities, 20% of parents report having rather small home libraries (up to 25 books), while extensive collections (over 100) are possessed by over 25% of families.

The proportions of first-graders from extremely affluent and poor families are equally small in Kazan and Krasnoyarsk. The financial standing of a family is presented as a binary variable in this study, which takes the "above average" value beginning with the category *We have no difficulty buying new furniture or major appliances…* and "below average" for all the previous choices. Most parents covered by the survey (over 40% in both cities) describe their financial standing as "slightly below average".

Both Kazan and Krasnoyarsk confirm their reputations as highly educated cities: over 50% of parents have higher education levels. We only use the mother's education as an indicator of the family's educational status, as educational background of the parents is usually more or less the same, but mothers traditionally play a greater role in raising children. As in the case of financial standing, the answers are converted into two categories: "higher education level" and "no higher education".

The percentage of non-Russian-speaking families is much higher in Kazan than in Krasnoyarsk, just as we presumed based on Kazan's specific status as a national republic.

The regional capitals differ very little in the percentage of children who attended a kindergarten in the previous year, yet formal preschool courses were attended by 18.8% more children in Kazan than in Krasnoyarsk.

Table 5. **Initial descriptive statistics on the variables**

| | | Krasnoyarsk | Kazan |
|---|---|---|---|
| Number of books at home | 0–25 | 21.1 | 22.5 |
| | 26–100 | 50.3 | 50.1 |
| | Over 100 | 28.6 | 27.4 |
| Financial standing | We live very frugally and sometimes don't even have enough money to buy food | 1.30 | 1.30 |
| | We have enough money for daily expenses, but buying clothes is rather difficult | 7.40 | 7.20 |
| | We have enough money for food and clothes, but buying small appliances (e. g. an iron, a hairdryer, etc.) is rather difficult right now | 10.10 | 6.50 |
| | We have enough money for food, clothes and small appliances but would have to borrow money to buy new furniture or major appliances (e. g. a TV, a fridge, etc.) | 44.30 | 42.90 |
| | We have no difficulty buying new furniture or major appliances, but we can't afford a new car (without taking a loan) | 26.00 | 29.40 |
| | We can buy anything except real property (an apartment or a summer cottage) without taking a loan | 9.30 | 11.00 |
| | We have no financial difficulties; if necessary, we can afford to buy a new apartment or build a new house without taking a loan | 1.7 | 1.6 |
| Mother's education | Incomplete secondary education | 2.00 | 2.30 |
| | Complete secondary education | 6.50 | 5.50 |
| | Secondary vocational education | 25.60 | 25.50 |
| | Incomplete higher education | 5.90 | 5.70 |
| | Higher education | 55.80 | 56.30 |
| | Master's degree | 3.30 | 2.80 |
| | Doctoral degree | 1.00 | 2.00 |
| Father's education | Incomplete secondary education | 2.90 | 2.50 |
| | Complete secondary education | 7.80 | 8.10 |
| | Secondary vocational education | 31.10 | 32.30 |
| | Incomplete higher education | 7.70 | 6.30 |
| | Higher education | 46.50 | 46.80 |
| | Master's degree | 2.10 | 2.20 |
| | Doctoral degree | 2.00 | 1.70 |
| Language spoken at home | Russian | 97.70 | 88.30 |
| | Other | 2.30 | 11.70 |
| Preschool experience | Attended a kindergarten in the previous year | 89.20 | 88.50 |
| | Attended preschool classes | 67.80 | 86.60 |

Table 6. **Regression analysis results: mathematics**

| Variable | Model | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Constant | 49.62** | 48.27** | 49.66** | 31.31** | 27.02** | 24.49** | 23.68** | 24.56** | 22.29** | 22.54** |
| Region | 0.73 | 1.13** | 1.1** | 1.12* | 0.91* | 0.84* | 0.82* | 0.67 | 0.44 | 0.46 |
| School status | | 2.58** | 2.6** | 2.77** | 2.51** | 1.91** | 1.87** | 1.71** | 1.66** | 1.66** |
| Sex | | | −2.79** | −2.78** | −2.82** | −3.03** | −3.00** | −3.07** | −3.09** | −3.01** |
| Age | | | | 2.5** | 2.68** | 2.83** | 2.90** | 2.93** | 2.95** | 2.91** |
| Kindergarten | | | | | 3.58** | 2.7** | 2.97** | 2.73** | 2.53** | 2.56** |
| Mother's higher education | | | | | | 4.26** | 4.42** | 3.79** | 3.76** | 3.78** |
| Financial standing | | | | | | | −0.06 | −0.02 | −0.08 | 0.05 |
| Books 25 | | | | | | | | −2.49** | −2.33** | −2.34** |
| Books 100 | | | | | | | | 0.75 | 0.72 | 0.72 |
| Language spoken at home | | | | | | | | | 2.57** | 2.53** |
| Formal preschool courses | | | | | | | | | | 0.02 |
| $R^2$ | 0.001 | 0.02 | 0.04 | 0.05 | 0.06 | 0.10 | 0.11 | 0.12 | 0.13 | 0.13 |

** $p < 0{,}01$; * $p < 0{,}05$.

**4. Regression analysis results**

Tables 6 and 7 present regression analysis results for all the models constructed[5].

Model 1 uses region as the only independent variable, and no difference is revealed between the regions at this stage. Model 2 includes the type of school: first-graders in schools of an advanced type score 1.5–3 points better than children enrolled in regular schools. Models 3–5 consider some personal characteristics of the children. The gender variable added to Model 3 appears to be significant: girls score about 3 points worse in math and 2 points better in reading than boys. According to Model 4, children aged a little older than their classmates tend to obtain significantly higher grades. Model 5 shows that children who attended a kindergarten in the previous year score almost 4 points better in both math and reading than those who did not. Model 6 includes the mother's education variable. It plays a statistically significant role, with better scores being demonstrated by children whose mothers have higher education levels. Model 7 considers financial standing additionally. This variable remains virtually in-

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[5] We use unstandardized regression coefficients showing how many points *y* changesper one point change in *x*.

Table **7. Regression analysis results: reading**

| Variable | Model | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Constant | 50.05** | 48.37** | 47.45** | 34.11** | 29.63** | 27.15** | 26.37** | 27.46** | 25.75** | 24.69** |
| Region | −0.09 | 0.41 | 0.43 | 0.42 | 0.21 | 0.16 | 0.13 | −0.02 | −0.18 | 0.09 |
| School status | | 3.22** | 3.20** | 3.04** | 2.75** | 2.15** | 2.19** | 2.00** | 1.94** | 1.88** |
| Sex | | | 1.83** | 1.98** | 1.94** | 1.80** | 1.81** | 1.76** | 1.75** | 1.77** |
| Age | | | | 1.83** | 2.03** | 2.17** | 2.23** | 2.20** | 2.20** | 2.21** |
| Kindergarten | | | | | 3.76** | 2.79** | 3.15** | 2.89** | 2.74** | 2.64** |
| Mother's higher education | | | | | | 4.36** | 4.40** | 3.74** | 3.72** | 3.66** |
| Financial standing | | | | | | | −0.09 | −0.08 | 0.04 | −0.03 |
| Books 25 | | | | | | | | −1.77** | −1.66** | −1.61** |
| Books 100 | | | | | | | | 1.33* | 1.34** | 1.31* |
| Language spoken at home | | | | | | | | | 2.00* | 1.90* |
| Formal preschool courses | | | | | | | | | | 1.47** |
| $R^2$ | 0.001 | 0.03 | 0.03 | 0.04 | 0.05 | 0.09 | 0.10 | 0.10 | 0.11 | 0.11 |

\*\* $p < 0,01$; \* $p < 0,05$.

significant, i. e. no correlation exists between the basic skills of children starting school and family income. Model 8 adds the number of books at home as another variable describing socioeconomic status. Children whose families keep few books at home score around 2 points worse in both subjects than those who can boast a large or medium-sized library. Model 9 also considers the language spoken at home. First-graders whose families mostly speak Russian at home perform better in mathematics and reading than students speaking another language to their family, this gap being statistically significant. Finally, Model 10 also contains the variable of formal preschool courses: this factor was found to be significant for reading but not for math.

As we can see, language spoken at home appears to be a significant factor for the development of mathematical and reading competencies in prospective first-graders (Model 9)[6]. Mathematical and

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[6] The "language spoken at home" variable is a more significant factor for the development of mathematical competencies than reading skills. This is probably due to the fact that both preschool teachers and parents often recognize the need to compensate for the lack of Russian-speaking practice only in terms of reading. The influence of insufficient proficiency in Russian on

Table 8. **Home preschool learning activities**

| Type of activity | Correlation with reading or mathematics |
|---|---|
| Reading books | Reading |
| Telling stories or fairytales | Reading |
| Singing songs | Reading |
| Playing letter games (e. g. letter cubes, lotto, etc.) | Reading |
| Discussing what you did together | Reading |
| Discussing what you read about together | Reading |
| Playing with words | Reading |
| Writing letters or words | Reading |
| Reading aloud names of shops, street signs, etc. | Reading |
| Learning poems or songs by heart | Reading |
| Learning counting-out rhymes | Mathematics |
| Playing number games (e. g. number cubes, dominoes, etc.) | Mathematics |
| Counting various objects | Mathematics |
| Playing puzzle games | Mathematics |
| Playing board games | Mathematics |
| Playing with model construction toys | Mathematics |

reading diagnostic test scores are largely the same for children in both cities, yet there are 10% more non-Russian-speaking families in Kazan. The question arises: how can the gap be closed? The percentage of children who attended formal preschool courses in the previous year differs noticeably between the cities. Besides, families in the two regions may engage in different educational activities and practices.

Let us test the hypothesis that formal preschool courses and family educational practices play an important role in compensating for the impact of the language spoken at home on the development of mathematical and reading skills. To do this, we compare the data on formal and parental preschool practices in families with different language backgrounds across the regions. This data is retrieved from parent questionnaires asking parents how often family members involved children in specific types of play-and-learn activities—like learning poetry by heart, writing letters, or playing with numbers—before bringing them to school (Table 8). Parents were offered a choice of seven answers, from "Never" to "A few times a day".

mathematical education is not realized, so no compensation attempts are made. Meanwhile, math tasks are always given in Russian, both in starting-level diagnostic tests and throughout the learning process.

Table 9. **Associations between the language spoken at home, home preschool activities, and formal preschool courses**

| City | Language | Home activities | Formal preschool courses | Number of students (%) | Average |
|------|----------|-----------------|--------------------------|------------------------|---------|
| Krasnoyarsk | Other | Math-oriented | No | 12 (40%) | −1.05 |
| | | | Yes | 18 (60%) | −1.04 |
| | | Reading-oriented | No | 12 (40%) | −1.05 |
| | | | Yes | 18 (60%) | −0.99 |
| | Russian | Math-oriented | No | 414 (32%) | −0.09* |
| | | | Yes | 878 (68%) | 0.09* |
| | | Reading-oriented | No | 414 (32%) | −0.17* |
| | | | Yes | 878 (68%) | 0.08* |
| Kazan | Other | Math-oriented | No | 25 (18.4%) | −0.56* |
| | | | Yes | 111 (81.6%) | 0.01* |
| | | Reading-oriented | No | 25 (18.4%) | −0.69** |
| | | | Yes | 111 (81.6%) | 0.12** |
| | Russian | Math-oriented | No | 129 (12.5%) | 0.00 |
| | | | Yes | 899 (87.5%) | 0.03 |
| | | Reading-oriented | No | 129 (12.5%) | −0.08 |
| | | | Yes | 899 (87.5%) | 0.08 |

** $p < 0,01$; * $p < 0,05$.

We calculate the indices of home preschool learning activities separately for reading and mathematics as a sum of parents' answers to all of the questions. Then, we convert the resulting sums into Z-scores with a mean of 0 and a standard deviation of 1.

Table 9 shows the results of a dispersion analysis performed using Student's t-test for the variables of reading- and math-oriented home preschool activities in the two cities, depending on whether or not the families speak Russian at home and whether or not they give their kids an opportunity to attend formal preschool courses.

As can be seen from Table 9, the percentage of children who did not attend any formal preschool courses in the previous year is much higher in Krasnoyarsk than in Kazan: 32% and 12.5%, respectively. Besides, only 60% of Krasnoyarsk children from non-Russian-speaking families (only about twenty in the sample) attended formal preschool courses, while nearly 82% of children from families with another native language attended such courses in Kazan. The indices of home preschool learning activities are statistically much higher in Krasnoyarsk

Table 10. **Parental practices and formal preschool courses in Kazan and Krasnoyarsk**

| Region | Language | Index | Spearman's rho | Reading-oriented parental practices | Math-oriented parental practices | Formal preschool courses |
|---|---|---|---|---|---|---|
| Krasnoyarsk | Other | Reading | Rank correlation<br>N | 0.364*<br>31 | 0.372*<br>31 | −0.110<br>30 |
| | | Math | Rank correlation<br>N | 0.208<br>31 | 0.184<br>31 | −0.259<br>30 |
| | | Formal preschool courses | Rank correlation<br>N | −0.020<br>30 | −0.004<br>30 | 1.00<br>30 |
| | Russian | Reading | Rank correlation<br>N | 0.222**<br>1294 | 0.104**<br>1294 | 0.051<br>1294 |
| | | Math | Rank correlation<br>N | 0.102**<br>1,294 | 0.101**<br>1,294 | 0.034<br>1,294 |
| | | Formal preschool courses | Rank correlation<br>N | 0.111**<br>1,292 | 0.086**<br>1,292 | 1.00<br>1,294 |
| Kazan | Other | Reading | Rank correlation<br>N | 0.315**<br>137 | 0.262**<br>137 | 0.271**<br>136 |
| | | Math | Rank correlation<br>N | 0.290**<br>137 | 0.369**<br>137 | 0.203*<br>136 |
| | | Formal preschool courses | Rank correlation<br>N | 0.279**<br>136 | 0.168<br>136 | 1.00<br>136 |
| | Russian | Reading | Rank correlation<br>N | 0.175**<br>1,033 | 0.140**<br>1,033 | 0.090**<br>1,030 |
| | | Math | Rank correlation<br>N | 0.068*<br>1033 | 0.102**<br>1033 | 0.049<br>1030 |
| | | Formal preschool courses | Rank correlation<br>N | 0.036<br>1,028 | 0.006<br>1,028 | 1.00<br>1,030 |

\*\* $p < 0{,}01$; \* $p < 0{,}05$.

Russian-speaking families and Kazan non-Russian-speaking families in cases where parents send their children to formal preschool courses.

Using the index of home preschool activities, we analyze the associations between family educational practices, starting-level first-graders' skills, and attending formal preschool courses in Kazan and Krasnoyarsk separately for Russian-speaking and non-Russian-speaking families (Table 10).

All the indices are insignificant in Krasnoyarsk non-Russian-speaking families (due to the small size of the subsample). In Russian-speaking families, home preschool learning activities correlate positively with attending formal preschool courses and math and reading scores. Yet, these indices are rather low, the possible exception being the correlation between parental practices and reading test scores.

Amongst Kazan's non-Russian-speaking families, parental pre-school activities correlate significantly and strongly with both attending formal preschool courses and starting-level first-graders' test scores. Meanwhile, correlations between the variables for Russian-speaking families are almost the same as in the relevant subsample in Krasnoyarsk.

Language spoken at home appears to be a significant factor in regression models. Although non-Russian-speaking families are 9.5% more numerous in Kazan than in Krasnoyarsk, math and reading skills of Kazan first-graders differ little from those of Krasnoyarsk school children. We can explain this compensation by differences in the correlations between attending formal preschool courses and the language spoken at home, on the one hand (children from non-Russian-speaking families attend formal preschool courses more often, and the correlation between attending the courses and the starting-level test scores is stronger), and between parental practices and the language spoken at home, on the other hand. Kazan's non-Russian-speaking families are the most concerned about the academic success of their children and thus try to support them in the preschool period through home learning activities and formal preschool courses, both methods proving effective.

## 5. Considering region-specific aspects when getting children ready for school

Dispersion of the dependent variable, explained by the regression models constructed, remains low. Obviously, starting-level basic mathematical and reading skills of first-graders are determined by a number of other factors that we did not consider. Among the factors associated with basic mathematical and reading skills analyzed in this study, the most significant are sociocultural capital (mother's higher education and a home library of over 100 books), early childhood education experience, and language spoken at home. We found a correlation between school readiness of first-graders and the status of school they apply for, i. e. there is a certain school demand for applicants to have a high level of basic skills, and a willingness of parents to provide such a level when they decide to send their children to a school of an advanced type.

The region variable was found to be statistically insignificant. First-graders in such different regional capitals as Kazan and Krasnoyarsk demonstrate pretty much the same levels of mathematical competencies and reading skills in diagnostic tests, with the rest of the abovementioned factors controlled. Otherwise speaking, the existing differences are successfully compensated for. Further data analysis designed to identify the means of such compensation has proved the often expressed researchers' belief that family plays the decisive role in getting children ready for school. Home preschool learning practices are especially important for non-Russian-speaking families.

Based on the evidence obtained, we can conclude that taking into account parental demands and the established family traditions of getting children ready for school is a promising method of considering region-specific aspects when building an education system. Thus, the widespread practice of sending children to formal preschool courses in Kazan is most probably the result of a deliberate policy of the local education authorities, adopted to satisfy the demands of parents concerned about their children studying in a non-native language. Therefore, the departments of education should focus more on supporting families in their children's development efforts and increasing their awareness of the factors influencing academic success in school. Searching for efficient ways of increasing parental literacy in preschool education is one of the promising directions for research in this area.

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# In Search of Lost Profiles:
## The Reliability of VKontakte Data and its Importance in Educational Research

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**Abstract.** The potential of VKontakte (VK), the Russian equivalent of Facebook, as a data source is now acknowledged in educational research, but little is known about the reliability of data obtained from this social network and about its sampling bias. Our article investigates the reliability of VK data, using the examples of a secondary school (766 students) and a university (15,757 students). We describe the procedure of matching VK profiles to real students. Direct matching permitted us to identify the profiles of around 18% of students. A special technique offered in the article increased this number up to 88% for school students and up to 93% for university students. We compared age, gender and GPA of identified students and those whom we did not find on VK. We also compared the structure of social relationships, retrieved from VK data, to the expected structure of students' social ties. We found that the structure of "virtual" social relationships reproduced both the socio-demographic division of students into grades, years of study or majors, and the spatial division into different school buildings or university campuses. To our knowledge, it is the first study of this kind and scale based on VK data. It contributes to the understanding of how reliable data from this SNS is, how its accuracy can be improved, and how it can be used in educational research.
**Keywords:** social networks, VKontakte, social network analysis, data reliability, friendship ties, academic achievements, school, university.

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Social networking services (SNS) have become an integral part of the lives of millions of people who use them to communicate with friends, exchange ideas, find jobs, organize events, and many other things [Boyd, Ellison 2008]. Facebook, the largest social networking site in the world, was founded only 12 years ago and now has around

1.5 billion monthly active users[1]. It is no surprise that researchers become concerned about how social networking sites influence various spheres of life, including education [Hew 2011; Aydin 2012; Wilson, Gosling, Graham 2012; Tess 2013; Koroleva 2015].

The particular attention towards social networking services also has to do with the fact that they revolutionized the availability of demographic and social data [Boyd, Ellison 2008]. Even the most comprehensive educational studies rarely involve more than a few tens of thousands of people, and most were restricted to much smaller samples. The largest international student survey, The Program for International Student Assessment (PISA), covered 510,000 school students from 62 countries in 2012 [OECD 2014]./Meanwhile Kramer with his colleagues [Kramer, Guillory, Hancock 2014] published the results of a Facebook experiment involving 700,000 users. The most far-reaching Facebook-based experiment involved 61 million users [Bond et al. 2012].

Not only do social media allow for doing research on a previously unavailable scale, but they also provide answers to new questions. Thus, friendship networks and peer effects have traditionally been investigated using surveys [Lomi et al. 2011; Flashman 2012; Ivaniushina, Alexandrov 2013; Dokuka, Valeeva, Yudkevich 2015]. However, this method provides no opportunity to establish and analyze the relations among students from different educational institutions. Such relations were a blind spot for education researchers until recently, but today they can be identified and explored using social media data. Social networking services also open the door to longitudinal data on social relations, providing access not only to status information but also to the whole history of user interactions [Lazer et al. 2009].

International research has traditionally focused on Facebook as the most popular SNS in the world. Seventy-one percent of American Internet users have Facebook profiles [Duggan et al. 2015]. The percentage is even higher in specific categories: in some universities, 96% of students use Facebook [Martin 2009]. Researchers explore how Facebook usage influences social integration of students [Madge et al. 2009], their social capital [Ellison, Steinfield, Lampe 2007; Steinfield, Ellison, Lampe 2008] and psychological well-being [Steinfield, Ellison, Lampe 2008]. VKontakte (VK) is the Russian equivalent of Facebook, and its data source potential has also begun to attract the attention of researchers. In particular, they find out how time spent on VK affects exam performance [Krasilnikov, Semenova 2014], analyze how friendship networks develop [Dokuka, Valeeva, Yudkevich 2015], show how VK data could be used to explore academic mobility [Alexandrov, Karepin, Musabirov 2016], etc.

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[1] Facebook (2015) Statistics. Facebook, Palo Alto, CA. http://newsroom. fb.com/company-info

However, there have been few examples of using VK data for educational research purposes so far. This appears to be rather difficult because little is known about the reliability of data obtained from this social network and about its sampling bias. For instance, School No. 1 of St. Petersburg is infamous for allegedly going to have 3,000 graduates in 2019, as judged by VK data. Difficulties also arise when researchers try to match listed students directly to their social media profiles. School and university students do not always specify their colleges and often use alternative forms of their names.

Our article investigates the reliability of VK data, using the examples of a Moscow school and a Moscow university. At the first stage, we obtained lists of school students indicating their GPAs, gender, grade and the school building they studied in, and lists of university students indicating their year of study, major and performance. Next, we searched for the VK profiles of those students. A direct matching (exact matches between full names and educational institutions on VK and in real life) only permitted us to identify the profiles of around 18% of students. By using information on friendship ties and a dictionary of first names with alternative forms, we increased the number up to 88% for school students and up to 93% for university students. We compared groups of students identified by different means and those whom we did not find on VK. We also added information on friendship ties and compared the reconstructed virtual university network to the real one.

We managed to demonstrate the possibility of retrieving highly reliable data from VK and the consistence between the structures of social networks reproduced using this data and those of educational institutions, including the division of schools into buildings and grades and division of universities into campuses and majors. To our knowledge, it is the first study of this kind and scale based on VK data. Its findings will help education researchers use the social media potential more effectively.

**1. VK data search software and procedure**

By signing up for VK, Internet users accept the VK Terms of Service, under which they "understand that the personal information posted by the User may become available to other Site Users and Internet users, be copied and disseminated by such users"[2]. VK, in its turn, provides an API (application programming interface) allowing one to do automatic search queries and receive information on users in cases where the user does not prefer to hide such information.

The software we developed makes requests to the VK API and obtains a list of all users who specified the given educational institution, within the predetermined age range. Then, it matches the obtained

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[2] VK (2016) *VK.com Privacy Policy* https://vk.com/privacy

profiles to the list of students provided by the educational institution, by full name. However, only a small percentage of students can be found on VK by such direct matching. To extract more information from the SNS, we applied two additional techniques.

First, we developed a dictionary of first names with alternative forms. If the software found Latin symbols in the user's surname, the operator would be offered a translation. This helped us to identify the users who wrote their surnames with Latin symbols, e.g. "Nabokov" instead of "Набоков". If the software found the same surname in the list of users as in that of students, it would ask the operator whether the first names were matching. As a result, we identified those users who used short forms of their first names, e.g. "Vova Nabokov" instead of "Vladimir Nabokov". All translations and recorded name matches (or mismatches) were saved to a special dictionary, so the operator did not have to answer the same question again.

Second, the software searched not only the users who specified the given educational institution but also the users who had a lot of friends from there. This technique, traditional for social network analysis, is used, for example, in Mislove et al., 2010.

In order to protect personal data of school students, we developed a customized version of the software that was launched locally on school computers and deleted all the names and VK logins after completing the procedure. Only completely anonymized data was used for further research. Information on university students (lists of students by majors and their academic achievements) was retrieved from publicly available sources (the university website). After the matching procedure, the student names and logins were deleted and only anonymized data was used.

The matching procedure revealed three groups of students: those not found on VK, those found by direct matching, and those found by our own method. We compared these groups based on their size, students' gender, age and academic performance. We used a chi-square test and a $t$-test to calculate the p-value.

We also constructed friendship networks and compared them to the structures of educational institutions. We expected that students of the same grade, year of study or major would be closely interconnected. To quantitatively express the effect of such group-based division, we calculated modularity Q. This value shows the proportion of friendship ties connecting students within one group (grade, major, etc.) reduced by the expected number of such connections in case they were distributed randomly. Q = 0 means the absence of any tendency to generate links within the group. The closer Q is to 1 (maximum value), the denser connections between the nodes within groups. In practice, Q takes on values from 0.3 to 0.7, while higher values are rare [Newman, Girvan 2004].

Table 1. **Percentage of students whose VK profiles were found using the proposed methods**

|  |  | Dictionary of first names with alternative forms | |
|---|---|---|---|
|  |  | No | Yes |
| Friend list | No | 18 | 27 |
|  | Yes | 57 | 88 |

Table 2. **Percentages of identified VK users who did not indicate their school and/or used alternative forms of their names, by age (grade)**

|  | Grade | | | | | | |
|---|---|---|---|---|---|---|---|
|  | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Percentage of students identified (%) | 85 | 89 | 88 | 90 | 88 | 91 | 85 |
| Percentage of students who did not indicate their school (%) | 64 | 72 | 69 | 74 | 70 | 58 | 72 |
| Percentage of students who used alternative forms of their names (%) | 39 | 36 | 29 | 33 | 33 | 31 | 38 |

## 2. Data reliability
### 2.1. School

Using the VK API, we found 908 users claiming to be under 18 and to be a student of the given school. Meanwhile, this school has only 766 students in grades 5–11, according to the list. This means that a portion of the students provided false information about themselves.

The number of VK friends claiming to be students of the same school can be an effective tool in identifying the real profiles of school students. Out of 458 VK users with no friends from the same school, only four (i. e. less than 1%) actually study in that school. Among the top 100 users with the highest number of friends in the given school, at least 83% are students of that school (Table 1).

The resulting coverage can be compared to a study analyzing Facebook profiles of American students, where the second-wave coverage was 84.6%, according to the publicly available data [Lewis et al. 2008].

Table 2 compares groups of students based on their age (grade). Approximately equal percentages of students were revealed in the social network for all age cohorts. The incidence of using alternative forms of names and indicating the school in the profile also does not change from grade to grade. None of the differences in the table approaches any statistical significance. The p-values calculated by a chi-squared test are above 0.5.

Table 3. **Groups of school students differing in the way of presenting their personal data on VK, by gender and academic performance**

|  | Girls (%) | GPA |
|---|---|---|
| Found on VK | 46 | 3.80 |
| Not found on VK | 48 | 3.79 |
| Those who did not indicate their school | 48 | 3.77 |
| Those who used alternative forms of their names | 50 | 3.79 |

Table 4. **Percentages of identified VK users who used alternative forms of their names, by age (year of study)**

|  | Year | | | |
|---|---|---|---|---|
|  | 1st | 2nd | 3rd | 4th |
| Percentage of students identified (%) | 92 | 94 | 94 | 93 |
| Percentage of students who used alternative forms of their names (%) | 30 | 32 | 32 | 34 |

Table **5. Groups of university students differing in the way of presenting their personal data on VK, by gender and academic performance**

|  | Girls (%) | GPA |
|---|---|---|
| Found on VK | 59 | 7.34 |
| Not found on VK | 58 | 7.13 |
| Those who used alternative forms of their names | 71 | 7.37 |

Similarly, no gender or GPA gap is observed between the groups of students found on VK, not found on VK, those who did not indicate their school, and those who used alternative forms of their names (Table 3), p-values being above 0.5.

**2.2. University** Similar results were obtained for university students. Out of 15,757 students, 93% were found on VK. This value varies from 75% to 100%, depending on the major.

There is no age difference between students found and not found on VK or between those using alternative and given names, yet students not found on VK perform on average worse (p-value $< 10^{-8}$), and girls use alternative names more often than boys (p-value $< 10^{-11}$).

Alternative name usage is different between school and university students. Twenty-seven percent of all alternative forms of names

Figure 1. **The VK friendship network reproduces school division into grades. Students of the same grade are mostly connected with friendship ties. The wider the age gap, the less likely students are to be friends**
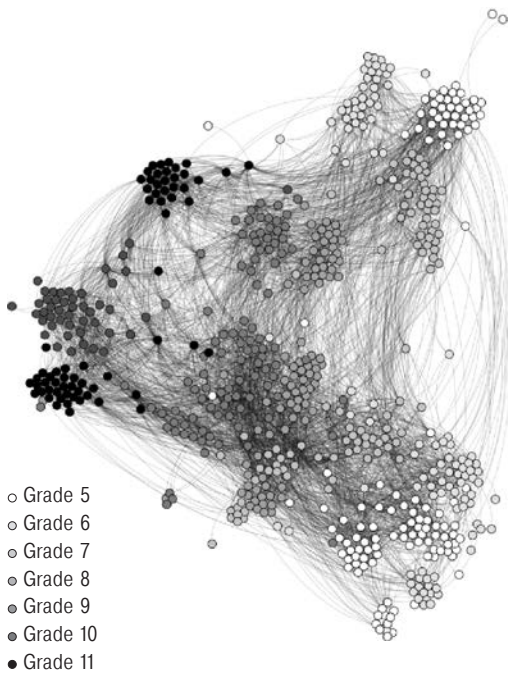
Figure 2. **The VK friendship network reproduces school division into buildings**



○ Grade 5
○ Grade 6
○ Grade 7
◉ Grade 8
◉ Grade 9
● Grade 10
● Grade 11

● Building 1
○ Buildings 2, 3
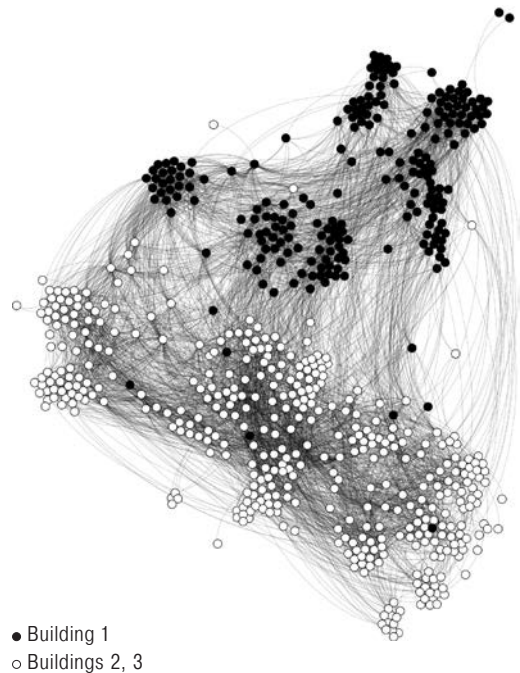
used by university students are typed using the Latin alphabet, while the proportion is only 8% among school students.

### 3. Friendship network structure
#### 3.1. School

We constructed a friendship network for all school students identified on VK (Fig. 1). We used ForceAtlas2 graph layout algorithm and Gephi Software for network visualization [Jacomy et al. 2014]. The higher connection between the nodes, the closer they are brought to one another by the algorithm. The resulting network structure corresponds to the division into grades, modularity $Q = 0.47$, the distance depending on the age disparity and being the greatest between the youngest and the oldest grades. The friendship network is additionally broken into two major clusters corresponding to different buildings of the recently merged schools, $Q = 0.35$ (Fig. 2).

#### 3.2. University

The VK friendship network reproduces division into years of study, $Q = 0.58$ (Fig. 3), campuses, $Q = 0.32$, and majors, $Q = 0.68$ (Fig. 4).

Figure 3. **The VK friendship network reproduces major division into years of study. The wider the age gap, the less likely students are to be friends**
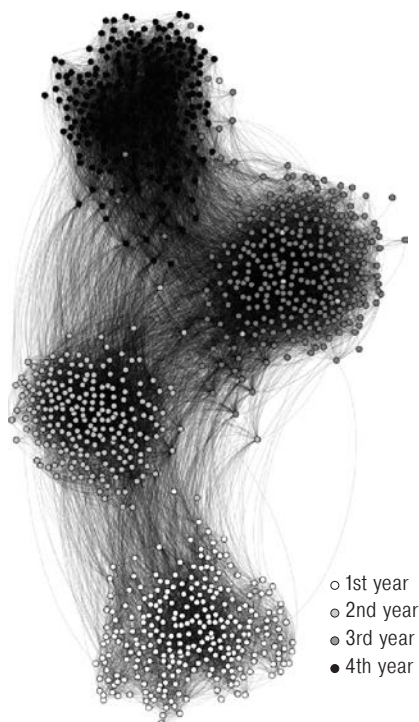
Figure 4. **The VK friendship network reproduces university division into majors and campuses located in different cities. The figure shows the friendship network of fourth-year students. Campuses are highlighted in different colors. The visible clusters within the campuses correspond to majors**



○ 1st year
◔ 2nd year
◕ 3rd year
● 4th year
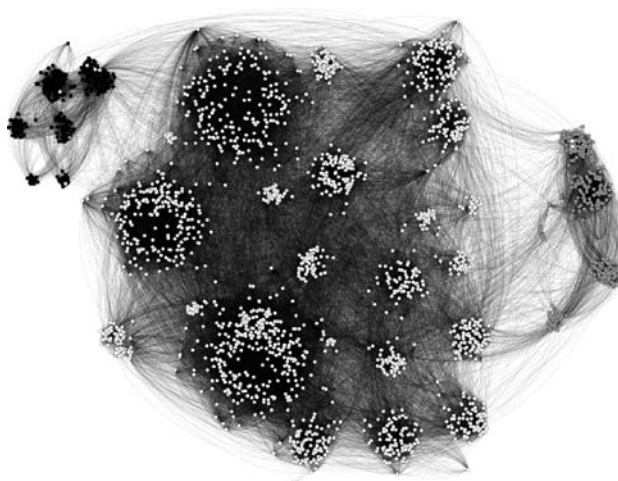


**4. The prospects of using VK data in educational research**

VK as a source of data offers a huge potential for educational research. However, using this data is associated with certain methodological difficulties. The results of our study allow us to provide specific recommendations on how to overcome those difficulties.

It does make sense to discount users with no VK friends from the same educational institution from the list of users claiming to be students of that institution. Only 1% of such users actually attend the given institution.

When matching the list of students to the list of VK users, alternative forms of names should be considered, as they are used by 35% of students. An effective identification tool is the additional search in friends of identified users: 69% of students do not indicate their educational institution in their profiles.

When using social media data, special attention should be paid to the potential sampling bias. For instance, it can be expected that middle school students will be represented less on VK than high school

students, or that lower-performing students will provide incorrect information more often, etc. Yet, we revealed no significant gender, age or performance differences between the groups of students of grades 5–11 found and not found on VK. Exceptions include a slightly lower GPA of students not identified on VK and a more frequent use of alternative forms of names by girls.

The total coverage of 88% for school students and 93% for university students indicates that the SNS is used by nearly all students. It would be interesting to reproduce this result using a larger sample and, particularly, to compare different regions and cities.

Our findings also confirm the value of information on VK friendship ties. We demonstrate that the structure of these ties correlates with the structure of the educational institution, reproducing not only the division of students into grades, years of study and majors, but also the spatial structure, such as the division of school into buildings.

Social networking services allow for a new perspective on traditional educational research topics. Since the late 1970s, researchers have been developing the tradition of studying social and cultural capital [Bourdieu 1986; Coleman 1988; Putnam 2001], and these constructs have also proved significant in educational research [DiMaggio 1982, Goddard 2003; Lareau, Weininger 2003]. Special emphasis is placed on the social reproduction of inequality [Bourdieu, Passeron 1990; Stanton-Salazar, Dornbusch 1995]. Today, we have a unique opportunity to test the sociological theories on newly available extensive empirical data.

Information on school students' cultural capital can be reconstructed from their specified interests, subscriptions and VK pages followed, all of which characterize their tastes and cultural preferences [Liu 2007; Lewis et al. 2012]. As for the social capital, SNS data allows for identifying weak ties (being friends on VK) as well as strong ones (comments on each other's posts, likes, etc.). Such data appears to be much more comprehensive and detailed than results of sociometric studies, which hardly ever go beyond contacts within one grade, ignoring cross-age and inter-school connections.

Social networking sites make it possible to investigate the relationship between social and cultural capital and academic achievements at both school and individual levels. Not only can geographical and social segregation be revealed and tracked online, but also the mechanisms of inequality reproduction can be studied: how students influence each other (peer effects, influence of friends on students' attitudes), how social and cultural capital affects the choice of educational trajectories (transfer to another school, transfer from school to university), etc.

The use of social media data not only opens new doors for education researchers but also raises new ethical questions. The availability of information on users does not depend exclusively on what they decide to make available anymore. For instance, it is possible to re-

store information on the users' university, graduation year and major [Mislove et al. 2010], sexual orientation [Bhattasali, Maiti 2015], romantic partners [Backstrom, Kleinberg 2014], or ideological affiliations [Bakshy, Messing, Adamic 2015] quite accurately. In our study, we show that even "naïve" means are enough to determine the school of students who decided not to self-report it on VK. Advanced machine learning algorithms will do it even better. SNS data often has to be merged with some additional information obtained from publicly available sources or educational institutions. With such matching, special attention should be paid to personal data anonymization in order to ensure privacy.

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# Participation of Russian Workers in Continuing Professional Education

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**Abstract.** In this paper, we analyze the participation rates of Russian workers in continuing professional education (CPE) using Rosstat data and sociological surveys, including the 2014 and 2015 Eurobarometer in Russia. We reveal considerable differences in the percentages of workers covered by CPE across age cohorts, personnel categories and, especially, industries. Our analysis shows that formalized CPE norms and standards in such industries as education and healthcare have a largely positive effect on the incidence of employee participation in advanced trainings. Next, we demonstrate that the data collection methods used by Rosstat do not allow for a comprehensive analysis of CPE participation rates in all industries, as only large and medium-sized companies are covered by the official statistics, while small businesses, which form the best part of the retail sector, are left out. Besides, the rigid regulatory framework of the official statistics makes it impossible to embrace the diversity of existing types and forms of CPE. There is no single method to measure the rate of participation in continuing education (not only professional), which we demonstrate in our review of methodologies used by Russian and foreign researchers. As a result, comparing the rates of participation in lifelong learning (including CPE) in different countries becomes a challenging task.

**Keywords:** continuing professional education, lifelong learning, adult education, advanced training, retraining/professional conversion, human capital, skill resources.

## 1. Введение

The education system does not just serve to supply highly qualified employees to the economy, as nowadays learning and professional self-improvement do not end with the completion of tertiary studies. Continuous renewal of employee competencies is required to integrate new process technologies and use the positive experiences of other market players. As a result, the economic efficiency of specific companies increases for the good of economy as a whole. The social function of lifelong learning consists in providing the opportunity for occupational conversion to those who find themselves unappreciated for some reason. Finally, learning new knowledge and skills not

only fills one's spare time with interesting and useful activities but also contributes to overall social development; this is becoming more and more widespread. It helps enhance the overall cultural and educational potential, expand and intensify social networks through interactions during various collective instructional and enlightenment practices, and bring together representatives of diverse socioeconomic classes.

The existing definitions of lifelong learning summarize the multiple aspects of this long-lasting knowledge accumulation process. There is even discrimination between lifelong learning and lifewide learning, the latter being about not only continuously enhancing one's knowledge in a specific field but also constantly broadening one's horizons and learning new disciplines. Lifelong learning includes school education, tertiary education, continuing professional self-improvement (organized and informal), as well as activities designed to acquire various competencies that are not always related to a primary occupation [Belyakov et al. 2006: 17]. There are "niche" domains of science studying school and tertiary education as well as self-educating leisure activities. So, lifelong learning is most often understood as adult education, with, notably, continuing professional education (CPE) as the most economically meaningful part of it[1].

The importance of CPE for the national economy is recognized at governmental level as well. For this reason, the Decree of the President of the Russian Federation No. 599 "On National Education and Science Policy Instruments" of May 7, 2012 underlines the need for increasing the proportion of the labor force involved in professional self-education and self-improvement[2].

**Indices of participation in lifelong learning and methods of their measurement**

A comparison of lifelong learning participation rates in Russia and European countries does not allow for a definitive conclusion, as the values depend largely on the data source. For instance, according to the 2014 Eurobarometer survey, the index of participation of workers aged 25–64 in adult learning in Russia is higher than in Germany, yet is ranked lower than in Latviaby the Russian Longitudinal Monitoring Survey (RLMS) conducted by the Higher School of Economics (HSE) (Table 1).

The problem is that researchers have still not agreed on a consistent measure of participation in lifelong learning as a whole and CPE in particular. For example, Eurostat[3] surveys assess the percentage of workers aged 25–64 who engaged in any form of lifelong learning

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[1] For more on the glossary of lifelong learning, see, for instance, [Belyakov et al. 2006; Klyucharev et al. 2014].

[2] http://rg.ru/2012/05/09/nauka-dok.html

[3] Eurostat. Short Description for Lifelong Learning http://ec.europa.eu/eurostat/tgm/web/table/description.jsp

Table 1. **Percentage of workers aged 25–64 involved in lifelong learning (not only professional development) in Russia as compared to European countries, 2013 (ranked in descending order)**

| Country | Percentage of workers involved in lifelong learning (%) | Country | Percentage of workers involved in lifelong learning (%) |
|---|---|---|---|
| Denmark | 31.4 | Germany | 7.8 |
| Switzerland | 30.4 | Malta | 7.6 |
| Sweden | 28.1 | Ireland | 7.3 |
| Iceland | 25.8 | Cyprus | 6.9 |
| Finland | 24.9 | Belgium | 6.7 |
| Norway | 20.4 | Latvia | 6.5 |
| France | 17.7 | Italy | 6.2 |
| Netherlands | 17.4 | Lithuania | 5.7 |
| Great Britain | 16.1 | Russia (as estimated by RMLSHSE) | 5.7 |
| Luxembourg | 14.4 | Poland | 4.3 |
| Austria | 14.0 | Turkey | 4.0 |
| Estonia | 12.6 | The former Yugoslav Republic of Macedonia | 3.5 |
| Slovenia | 12.4 | Greece | 3.0 |
| Spain | 11.1 | Hungary | 3.0 |
| EU as a whole (28 countries) | 10.5 | Croatia | 2.9 |
| Czech Republic | 9.7 | Slovakia | 2.9 |
| Portugal | 9.7 | Romania | 1.8 |
| Russia (yearly average, according to the 2014 Eurobarometer) | 9.0 | Bulgaria | 1.7 |

*Sources:* Eurostat, Eurobarometer in Russia, RMLSHSE, author's estimates.

(obtaining new knowledge as perceived by respondents) in the four weeks preceding the survey. According to the methodology used by the Russian Monitoring of Continuing Professional Education conducted by the Center for Economics of Lifelong Learning of the Russian Presidential Academy of National Economy and Public Administration (RANEPA)[4], researchers consider participation of the population, including the unemployed, in any type of lifelong learning (mainly or-

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[4] Eurobarometer in Russia, a RANEPA project http://www.ranepa.ru/uceni-yy-issledov/strategii-i-doklady-2/evrobarometr

ganized. i. e. in the form of trainings, courses, etc.) in the five years preceding the survey. Meanwhile, the RLMSHSE[5] measures the percentage of the population that engaged in any kind of continuing education (organized but not necessarily professional) in the 12 months preceding the survey. Finally, Rosstat[6] data covers employees of large and medium-sized companies who received continuing professional education during the fiscal year, as reported by the companies themselves. Obviously, the difference in the calculation methods makes the comparison of available participation indices technically incorrect, though not impossible.

**Specific features of participation of Russian workers in CPE**

According to Rosstat statistics, 13.8% of employees (15.2% in the 25–64 age group) received continuing professional education in various forms in 2013[7]. If we extrapolate this result, we can assume that it will take seven years to engage 100% of employees in lifelong learning, which is even more than in the Soviet standard of "continuing education every five years". It is obvious, however, that this index is a good example of the tyranny of averages, as no allowance was made for differences across industries, professional categories, or age cohorts.

People usually lose passion for learning with age. Besides, employers, the State included, are often uninterested in providing education to older employees, pre-retirement age workers particularly [Avraamova, Klyachko, Loginov 2015]. According to the statistical data that RANEPA collects regularly for the Eurobarometer project[8], about 45% of Russian employees above the age of 18 had engaged in lifelong learning in the five years preceding the survey in 2015[9]. The

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[5] Russian Longitudinal Monitoring Survey of the Higher School of Economics (RLMSHSE) is conducted by the National Research University Higher School of Economics and Demoscope CJSC with participation of the Carolina Population Center (University of North Carolina, Chapel Hill) and the Institute of Sociology, Russian Academy of Sciences: http://www.cpc.unc.edu/projects/rlms; http://www.hse.ru/rlms

[6] Rosstat. Continuing Professional Development of Employees http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/bbd2da8043f81ba38a78cbd92111eac8

[7] The most recent Rosstat data available; the next update is due in 2016.

[8] The study was conducted using surveys in ten regions of Russia in 2014 and 2015. The total sample included 6,000 observations. The findings of surveys among working respondents (N = 3,400) were used to analyze the participation of adults in continuing professional education. The module of items on lifelong learning was developed and integrated into the Eurobarometer questionnaire by the RANEPA Lifelong Learning Economics Center, which has monitored continuing professional education in priority industries of Russia since 2013.

[9] The questionnaire items were formulated to ask about continuing education in general; 45% of workers who engaged in continuing education in the pre-

Figure 1. **Percentage of workers engaged in continuing education across age cohorts**, Rosstat, 2013 (%)

| Age cohort | % |
|---|---|
| Average | 13,8 |
| Under 25 years | 14,1 |
| 25–29 years | 16,5 |
| 30–39 years | 16,2 |
| 40–49 years | 15,2 |
| 50–59 years | 10,8 |
| 60–64 years | 7,5 |
| 65 and older | 5,9 |
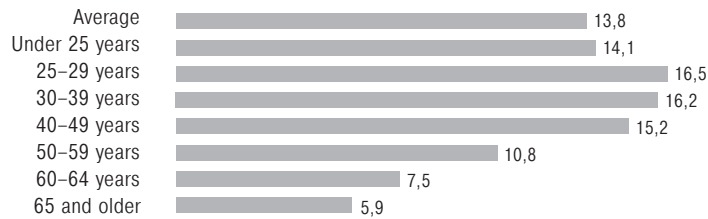
highest participation rate of over 50% was observed in the age cohorts from 25 to 39 years. At the same time, only one worker out of three received continuing education for the same period in the 60+ age group. Involvement rates in the youngest cohort (under 25) do not reach maximum values because young specialists, who clearly possess no high-level competencies, obtain specific skills that they need right at their workplace. This age-related differentiation is confirmed by Rosstat statistics. As shown in Figure 1, the highest participation rates are observed in the age cohorts from 25 to 39 years, while only one in ten workers aged over 50 reported having engaged in lifelong learning.

Eurobarometer statistics show that over 60% of Russian workers aged between 18 and 39 would like to obtain some kind of continuing education. The percentage among workers aged over 40 and those over 60 is noticeably lower, being 47% and 30%, respectively. Quite naturally, qualitatively different approaches should be applied to increase the CPE involvement of the youngest and the oldest cohorts, as the latter requires a much stronger impetus for learning. However, the employer's attitude often does not contribute to continuing development of employees over 40. According to the 2015 Eurobarometer, employer's disinterest was reason number one for the older cohorts not having engaged in continuing education while willing to do so in the five years preceding the survey (no more than 9% among those under 40, 14% in the 40–49 cohort, and over 18% among those aged 50–59). Therefore, if we make a point of increasingthe participation of Russian workers in CPE, we should pay particular attention to the elder generation.

However, differences between worker categories produce a much more considerable differentiation in terms of continuing professional education than differences between age cohorts. What catches the eye right away is a huge dip in the "other employees" category.

vious five years used their own resources to pay for it, which implies that it was not only professional education, as individuals can enrich their knowledge in any area, not only for the purpose of upgrading their skills.

Figure 2. **Percentage of workers participating in continuing education across different worker categories**, Rosstat, 2013 (%)



| Category | Value |
|---|---|
| Average | 13,8 |
| Managers | 19,1 |
| Specialists | 16,6 |
| Other employees | 5,1 |
| Blue-collar workers | 12,2 |
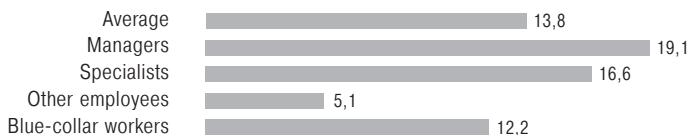
Rosstat uses this term to refer to third-class employees, as classified in OKPDTR[10], who mostly include non-manual workers holding professional positions that require no higher education (clerks, cashiers, conductors, etc.). Sociologists traditionally define them as semi-professionals (see, for instance, [Anikin, 2009]). They account for a little more than 3% of the total employed population, and if we leave them out of the analysis, the average percentage of workers involved in continuing education comes to 14.6%. Managers participate in lifelong learning more often than others: over 19% of managers were engaged in continuing education in 2013, as compared to 17% of specialists and only 12% of blue-collar workers, according to Rosstat.

Sociological research also proves that semi-professionals engage in continuing education less often than other types of workers. According to the 2015 Eurobarometer[11], over 60% of managers and about 50% (56% in the public sector) of specialists had engaged in CPE in the five years preceding the survey. Meanwhile, the rate was 43% among clerks (office workers), 27% among regular retail workers, and 25% among blue-collar workers[12]. The difference in the Rosstat and Eurobarometer estimates of the percentage of workers who received continuing education is explained by the difference in the methods of data collection: Rosstat deals with information on the most qualified segment of professional workers, i.e. those employed in large and medium-sized enterprises, whereas the non-qualified workforce, mostly used by small businesses for various reasons, remains beyond the official statistics.

CPE participation rates for different worker categories also differ in the public and private sectors. According to the 2015 Eurobarometer, the CPE participation rates in the public sector do not depend on

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[10] OKPDTR stands for the All-Russia Classifier of Occupations, Positions and Wage Categories OK 016–94: http://base.garant.ru/1548770/

[11] Eurobarometer measures the percentage of Russian workers who engaged in *any* type of continuing education in the last five years. Technically, it is incorrect to compare these rates with those of Rosstat, but our aim is to demonstrate that sociological data is validated by statistics.

[12] The 2015 Eurobarometer also discriminates among businessmen and the self-employed (46% participation rate), agricultural workers (33%) and law enforcement officers (43%).

Figure 3. **Industries with the highest rates of participation of workers in continuing education (as classified in OKVED)**, Rosstat, 2013 (%)

| Industry | Value |
|---|---|
| Fossil fuel extraction | 30,7 |
| Production of coke and oil products | 29,9 |
| Production of other materials | 28,2 |
| Production of metals and metal products | 25,9 |
| Production of machines and equipment | 23,2 |
| Chemical production | 23,0 |
| Transport | 19,8 |
| Production of rubber and plastic products | 19,2 |
| Production of machines and equipment (excluding the military-industrial complex) | 18,5 |
| Utilities industry | 18,2 |

the age of workers. Besides, a relatively small difference is observed between the percentages among managers of different age cohorts: 67% (i. e. on average 13.4% yearly) of managers aged under 39 engaged in continuing education in the five years preceding the survey, as compared to 54% among managers aged over 40. The respective rates for other worker categories in the public sector were as follows: 58% and 39% among specialists, 52% and 34% among office workers, 36% and 17% among retail workers, 29% and 21% among blue-collar workers. Thus, the public-sector continuing education standards provide a comparatively higher level of participation in CPE throughout the whole period of employment, which cannot be said of other types of workers.

Industry-based differentiation of the rate of participation in CPE was found to be the highest. Mining and mineral processing industries proved to be the most successful in this regard, especially those dealing with oil, gas and metals (Fig. 3). This should come as no surprise, as the primary sector of the Russian economy burgeoned and flour-

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[13] All-Russia Classifier of Economic Activities

ished during the last decades, giving birth to major market players that need and can afford to introduce and develop their own CPE systems.

Enterprises involved in machine construction, maintenance and operation also show high rates of participation of workers in CPE. These include aerospace manufacturers, so no wonder they do their best to upgrade their workers' skills, which form their competitive edge in the market, among other things. The same can be said of the chemical and energy industries, where low qualifications could lead to industrial disasters.

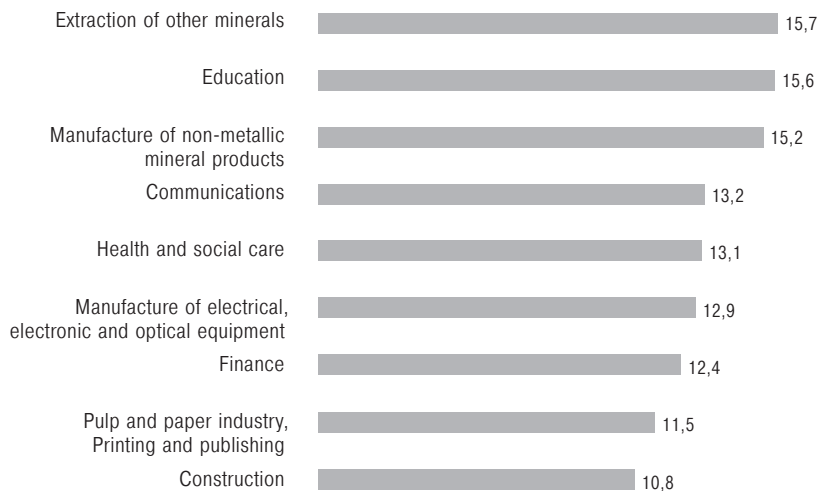Many of the large and medium-sized enterprises in the industries specified in Figure 3 have developed and integrated a systems staffing approach. To attract and/or prepare highly-qualified workers, they establish corporate universities and training centers, develop customized training modules, knowledge-based systems, professional development and retraining programs, and bring in higher education institutions. Many of such enterprises manufacture products considered to be Russia's major export earners, which imposes higher requirements for quality and manufacturing technology, and consequently for personnel qualification. In addition, global competition impels those companies to care about their prestige, in particular by demonstrating their social responsibility. For example, they involve young people actively, engaging to provide them with professional education.

Figure 4 shows the list of industries that demonstrate moderate rates of participation of workers in CPE. As with the leaders, an extractive industry tops the list. Interestingly, continuing education was pursued by only 13% of the workers of large and medium-sized enterprises in such a knowledge-intensive industry as the manufacture of electronic and optical equipment in 2013. This requires a closer analysis. Notably, 27% of electronic and optical equipment manufacturers (except small businesses) integrated various types of innovations in 2013, according to the same Rosstat. As a comparison, the overall industrial production index did not exceed 11%[14]. Clearly, these innovations would suggest that employees must have beentaught to integrate and use them, which means that the industry apparently offers some types and forms of continuing professional education that are kept beyond the official statistics.

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[14] Innovation activity of industrial manufacturers (the proportion of industrial manufacturers that integrate technological, organizational and/or marketing innovations in the total number of surveyed companies, annual percentage). Form No. 4-Innovation defines industrial manufacturers as legal entities, except small businesses, whose economic activities include extraction of minerals and energy, processing, as well as generation and distribution of electricity, gas and water (except trade of electricity and fuel gas supplied via distribution networks). The index is calculated as a proportion of the number of industrial manufacturers engaged in technological innovations to the overall number of surveyed companies.

Figure 4. **Industries that demonstrate moderate rates of participation of workers in CPE (as classified in OKVED)**, Rosstat, 2013 (%)

| Industry | Value |
|---|---|
| Extraction of other minerals | 15,7 |
| Education | 15,6 |
| Manufacture of non-metallic mineral products | 15,2 |
| Communications | 13,2 |
| Health and social care | 13,1 |
| Manufacture of electrical, electronic and optical equipment | 12,9 |
| Finance | 12,4 |
| Pulp and paper industry, Printing and publishing | 11,5 |
| Construction | 10,8 |

Education and healthcare hold an exceptional position due to the existing priorities in teaching specific categories of workers. The overwhelming majority (about 90%) of people employed in education and healthcare belong to the manager and specialist categories, where over 20% of workers received continuing education in 2013. Physicians are required to participate in advanced training programs at least every five years, and the same used to apply to teachers before 2013[15]. The percentage of education and healthcare workers who engaged in continuing education increased between 2010 and 2013, though only slightly (by 2% approximately). As we can see, these two largely government-owned industries are quite well-off in terms of CPE, and this is an instance of a positive outcome provided by setting CPE norms and standards legislatively.

Unlike in all other industries, telecommunications agencies provided continuing education to almost 20% of "other employees" (with lower participation rates in other worker categories: 17% among managers, 11% among specialists, and 13% among blue-collar workers). It is fair to assume that this lack of necessity to upgrade skills of any category of workers but semi-professionals (whereas they hardly account for 6% in the whole industry) is an industry-specific characteristic. Naturally, this assumption can only be verified using an in-depth

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[15] The legislative regulation allowing teachers to take training courses at least every three years was introduced by Federal Law of the Russian Federation No. 273-FZ "On Education in the Russian Federation" of December 29, 2012. Obviously, these changes had no impact on the 2013 statistics.

Figure 5. **Industries—outsiders in CPE participation rates (as classified in OKVED)**, Rosstat, 2013 (%)

| Industry | % |
| --- | --- |
| Woodworking | 9,5 |
| Real estate industry | 9,0 |
| Other types of production | 7,2 |
| Food production | 6,7 |
| Other public utility, social and personal services | 5,8 |
| Textile and garment | 5,5 |
| Retail trade and everyday services (including automotive repair) | 4,9 |
| Agriculture, hunting and forestry | 4,5 |
| Fishing and fish farming | 4,4 |
| Leather and leather products industry | 4,1 |
| Hotels and restaurants | 4,0 |
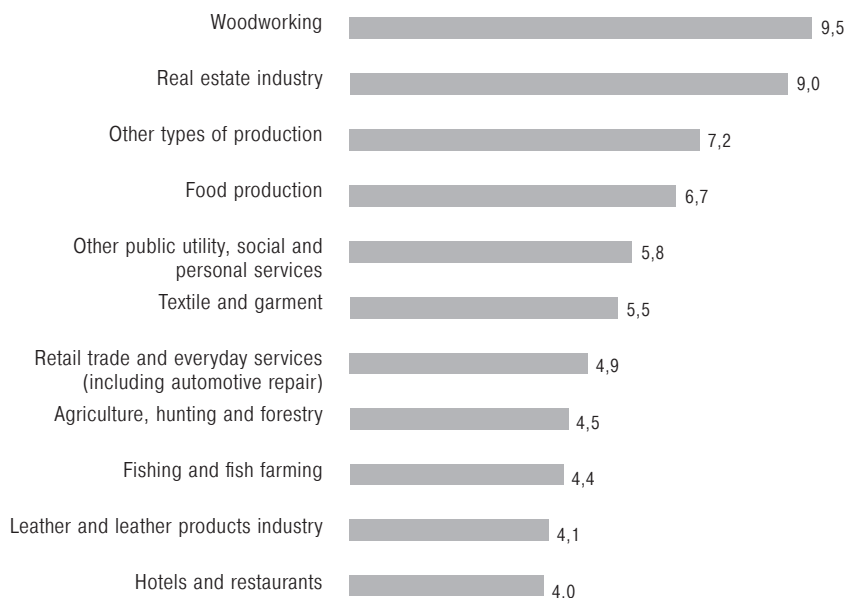
empirical study of CPE characteristics in the telecommunications industry.

Figure 5 presents the outsider industries, where less than 10% of workers are engaged in continuing education in 2013, as reported by Rosstat. Obviously, these industries require less qualified labor than the real sector, and CPE may be not demanded at all. At the same time, it is very likely that the types and forms of training practiced in these industries are not covered by the official statistics. For instance, the best-in-class hospitality companies representing major international hotel brands (Marriott, Hilton, etc.) implement corporate lifelong learning programs[16] that embrace corporate universities, internships, seminars, trainings, employee turnover, etc. They set industry standards, which are then adopted by smaller market players.

The 2013 Rosstat surveys estimated the average annual number of employees in the retail sector to be 13.1 million people. However, only data on large and medium-sized enterprises is considered when assessing the CPE participation rates, while small businesses are left out. Thus, the base value is 2.3 million employees for the retail industry. Abundant small businesses are a typical feature of this sector. For

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[16] For more on the personnel practices of the mentioned companies, see their official websites: http://jobs.hiltonworldwide.com/index.php?language=en, https://www.marriott.com/careers/working-for-marriott.mi

Table 2. **Different absolute indices of
the number of employees,** Rosstat

| Different absolute indices of the number of employed population | 2013 |
|---|---|
| Payroll-based number of employees (base for calculating the CPE participation rates) | 31 659 892 |
| Average number of employees (statistical book data)[a] | 45 815 640 |
| Average annual number of employees (Rosstat survey)[b] | 71 391 460 |

*Sources:* [a] The 2013 data was taken from the Rosstat Statistical Book: Rosstat (2014) *Regiony Rossii. Sotsialno-ekonomicheskie pokazateli. 2014: Stat. sbornik* [Regions of Russia. Socioeconomic Indicators. 2014: Statistical Book], Moscow, pp. 92–93]; [b] Rosstat. The number of employees in the industry: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/wages/labour_force/#.

example, the energy industry does not have this huge gap between the average annual number of employees and the CPE participation rate calculation base (2.3 million and 1.7 million, respectively). Otherwise speaking, the official statistics are unable to show a true picture of CPE in the industries shown in Figure 5 due to the methods used.

The problem of overestimated CPE participation rates applies to all industries, as the Rosstat methodology only counts large and medium-sized companies that are more concerned about employee education and often have a greater opportunity to provide it. In 2013, the number of workers (Table 2) used as a base for calculations made 69% of the average number of employees and 44% of the "average annual number of employees in the industry" (estimated by Rosstat based on a representative sample survey). In other words, Rosstat data does not allow for assessing the overall situation with the CPE of working population, let alone establishing the causes of revealed differences across industries, age cohorts and professional categories. Neither does it make it possible to assess the demand for other types and forms of continuing education, particularly in cases where employers are unaware of their employees having taken some courses. Nevertheless, the findings in this data analysis are certainly valuable for empirical research in the field.

**The most widespread types and forms of CPE in Russia**

The Rosstat methodology defines three types of continuing professional education, discriminating among various training programs[17]:

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[17] This refers to the methodology of 2013. In 2010, there used to be one more type of CPE: "targeted training courses", i. e. continuing professional development for blue- and white-collar workers provided to familiarize them with new machines, equipment, materials, processes, progressive forms of labor organization, employment legislation, equipment operation and maintenance rules, workplace safety requirements, and quality improvement is-

continuing professional education (development)[18], professional development, and employer-funded professional education.

*Continuing professional education (development)* is designed to satisfy employee's educational and professional needs, provide professional development, and ensure that employee qualifications meet the changing requirements of the profession. The following programs are included:

- Professional retraining to acquire competencies required for a new occupation; professional conversion. Successful graduates receive a diploma of professional conversion. Full-time and part-time/internship programs are available.
- Advanced training to upgrade and/or develop new competencies required for a profession and/or to enhance the level of proficiency in the existing competencies. Successful graduates receive a certificate of advanced training. Full-time and part-time/internship programs are available.

*Professional education* is designed to enable employees to acquire knowledge, skills and competencies required to perform specific duties or functions (demanded for the given type of blue- or white-collar profession). Successful graduates receive a certificate of blue- or white-collar profession that assigns them a class, a category, or a grade. Professional education can take the form of on-the-job training, including mentorship. The following programs are included:

- Professional training in specific blue- and white-collar professions (for those who did not have any profession before);
- Retraining of blue- and white-collar workers (professional education for those with a blue- or white-collar profession to teach them another profession so that they meet the manufacturing or occupational requirements);
- Advanced training for blue- and white-collar workers (professional education for those with a blue- or white-collar profession to enhance their professional knowledge, skills and competencies consistently without increasing the level of education).

*Employer-funded professional education* is a type of education that workers obtain in professional education institutions of all lev-

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sues, as well as other issues designed to solve specific technical, economic and other problems. Apparently, this type of CPE was merged with professional education in 2013.

[18] It is our understanding that "continuing professional education" includes all types of programs described in the Rosstat methodology. Therefore, we will hereinafter use the term "continuing professional development" to refer to specific CPE programs so as to avoid ambiguity.

Table 3. **Percentage of workers engaged in different types of CPE programs across worker categories**, Rosstat, 2013 (% of all employees in the category engaged in CPE)

| Type of CPE | Managers | Specialists | Other employees | Blue-collar workers | Average |
|---|---|---|---|---|---|
| Continuing professional development | 81,5 | 87,6 | 44,9 | 14,3 | 55,2 |
| Including programs: | | | | | |
|     Professional retraining | 11,3 | 6,7 | 14,5 | 33,6 | 10,7 |
|     Advanced training | 89,3 | 93,8 | 87,1 | 67,8 | 90,0 |
| Professional education | 19,4 | 12,9 | 55,7 | 86,9 | 45,6 |
| Including programs: | | | | | |
|     Professional training in specific blue- and white-collar professions | 25,3 | 31,8 | 27,6 | 26,9 | 27,4 |
|     Retraining of blue- and white-collar workers | 8,8 | 6,2 | 8,6 | 18,9 | 16,4 |
|     Advanced training for blue- and white-collar workers | 68,0 | 63,6 | 64,6 | 56,0 | 57,9 |
| Employer-funded professional education | 0,6 | 1,2 | 2,2 | 0,7 | 0,9 |
| Including: | | | | | |
|     Initial professional education | 0,0 | 0,0 | 9,1 | 28,6 | 11,1 |
|     Secondary professional education | 16,7 | 25,0 | 36,4 | 42,9 | 33,3 |
|     Higher professional education | 83,3 | 75,0 | 59,1 | 28,6 | 55,6 |

*Note:* Values above the average are highlighted here in and Table 4. As one and the same employee could engage in different programs and types of CPE, the sum of percentages may exceed 100%.

els. Successful graduates receive a diploma of the relevant level of education.

In 2013, 55% of all workers covered by CPE participated in continuing professional development programs, 46% in professional education programs, and 1% or less studied in professional education institutions, their education funded by employers[19]. Advanced training prevailed among the continuing professional development programs (professional retraining was provided to only 6% of all CPE participants). Advanced training (26%) and professional training (13%) programs were the most popular in professional education. Few employees engaged in employer-funded professional education, and they most often obtained higher professional education (0.5%).

Table 3 shows that continuing professional development programs are most often completed by specialists and managers, while blue-collar workers take professional education courses more often.

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[19]  The sum of percentages exceeds 100%, as one and the same employee could engage in more than one CPE program during the year.

Table 4. **Percentage of workers covered by different CPE programs across age cohorts**, Rosstat, 2013 (% of all employees in the cohort engaged in CPE)

| Type of CPE | Age (years) | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|
| | < 25 | 25–29 | 30–39 | 40–49 | 50–59 | 60–64 | ⩾ 65 | |
| Continuing professional development | 37,5 | 46,2 | 54,3 | 59,7 | 61,6 | 70,9 | 79,5 | 55,2 |
| Including programs: | | | | | | | | |
|     Professional retraining | 16,8 | 14,3 | 11,4 | 9,5 | 8,4 | 7,1 | 5,9 | 10,7 |
|     Advanced training | 84,0 | 86,4 | 89,3 | 91,3 | 92,4 | 93,8 | 94,8 | 90,0 |
| Professional education | 63,3 | 54,6 | 46,6 | 41,2 | 39,2 | 29,8 | 21,2 | 45,6 |
| Including programs: | | | | | | | | |
|     Professional training in specific blue- and white-collar professions | 38,4 | 30,4 | 26,2 | 24,0 | 24,0 | 24,2 | 22,2 | 27,4 |
|     Retraining of blue- and white-collar workers | 18,3 | 16,8 | 16,5 | 16,0 | 15,6 | 15,1 | 11,8 | 16,4 |
|     Advanced training for blue- and white-collar workers | 46,9 | 54,9 | 58,8 | 61,4 | 62,0 | 61,7 | 66,5 | 57,9 |
| Employer-funded professional education | 4,1 | 1,3 | 0,7 | 0,5 | 0,3 | 0,3 | 0,3 | 0,9 |
| Including: | | | | | | | | |
|     Initial professional education | 12,2 | 7,7 | 14,3 | 20,0 | 33,3 | 0,0 | 0,0 | 11,1 |
|     Secondary professional education | 29,3 | 23,1 | 28,6 | 40,0 | 33,3 | 33,3 | 33,3 | 33,3 |
|     Higher professional education | 61,0 | 69,2 | 57,1 | 60,0 | 33,3 | 33,3 | 33,3 | 55,6 |

Semi-professionals engage in employer-funded professional education more frequently than other types of workers. Blue-collar workers engage in professional conversion programs in all types of CPE more often than others, while all other categories take advanced training courses much more often, and specialists are retrained less often than any other category of workers. Statistics confirm the sociological findings (see, for example, [Karavay, 2016]) squaring employee enthusiasm about CPE initially with searching for a new job. Meanwhile, analysis of Rosstat data reveals that employers tend to provide education to their workers with a view to transferring them to another department. These conclusions may be regarded as evidence that the Russian economy does not need a number of highly-qualified niche experts.

A cohort analysis shows that the number of workers participating in continuing professional development is increasing in older cohorts, while the percentage of those who take professional education courses is going down (Table 4). Professional retraining programs—both in professional education and continuing professional development—are more demanded among youth, as the percentage of work-

ers covered by these programs is relatively high in younger cohorts. Contrastingly, advanced training is more popular among senior employees. Employer-funded professional education is often pursued by young people under 25, and these are largely higher education programs. Statistics demonstrate that CPE solves qualitatively different problems in age groups under and over the age of 30. At the start of their careers, people are more likely to try to "find themselves" by engaging in retraining courses (mostly within professional education), whereas those aged over 30 tend to enhance their professional competencies by using more formalized training paths (CPE advanced training programs).

Continuing professional development programs prevailed in such industries as education (93% of all employees in the industry covered by CPE), healthcare (92%) and public utility services[20] (73%). As for the rest of the industries, over half of the workers covered by CPE (65% on average) participated in professional education programs.

Quite expectedly, a comparison between different worker categories based on the statistics provided by companies shows that managers of all levels engage in continuing education more often (Fig. 6), followed by specialists and blue-collar workers.

The year 2013 saw a noticeable decline in the CPE participation rate compared to 2010: from 15.8% to 13.8%, according to Rosstat. Hence, the index reduced by 2% in two years. White-collar workers and managers appeared to be the most affected (1.76- and 1.35-fold reductions, respectively), while the category of blue-collar workers suffered the least (about 1% reduction).

Over 18% of employees aged under 30 received continuing professional education in 2010, but the rate dropped by almost 3% to 15.6% in 2013. Among older workers, the decline in the CPE participation rate was only 1.3% (from 14.9% to 13.6%)[21]. However, young people still engaged in CPE more often than their elder colleagues (Fig. 7). Hence, we can see that the proportion of Russian workers covered by CPE dropped in 2013 compared to 2010 in all working population groups, whether based on the age or worker category.

When comparing the rates of participation in different CPE programs in 2010 and 2013, we should keep in mind that allowability of such a comparison is rather conditional, as the methods of calculation changed a lot during that period. According to Rosstat (Table 5), 2.2 million people were involved in continuing professional development programs and 1.2 million in continuing education programs in 2010, compared to 2.4 million and 2.0 million in 2013, respectively. The 2013 statistical data does not cover workers who participated in

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[20]  "Other public utility, social and personal services" in OKVED.

[21]  Meanwhile, the CPE participation rate reduced from 16.5% to 14.1% among workers aged under 25 and from 19.6% to 16.5% among those aged 25–30.

Figure 6. **Percentage of workers of different categories covered by CPE in 2010 and 2013**, Rosstat (%)

| | |
|---|---|
| Managers | 25,7 / 19,1 |
| Specialists | 18,6 / 16,6 |
| Other employees | 9,0 / 5,1 |
| Blue-collar workers | 13,1 / 12,2 |
| Average | 15,8 / 13,8 |
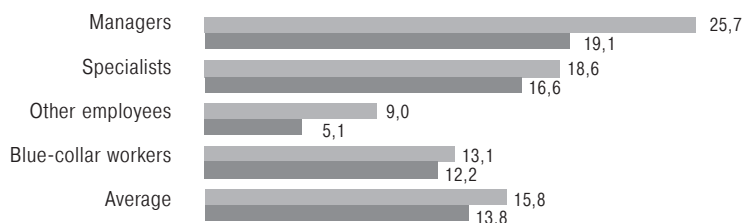
Figure 7. **Percentage of workers covered by CPE in 2010 and 2013 across two major age cohorts**, Rosstat (%)

| | |
|---|---|
| Under 30 years of age | 13,8 / 15,8 |
| Aged over 30 | 13,6 / 14,9 |
| Average | 15,6 / 18,4 |
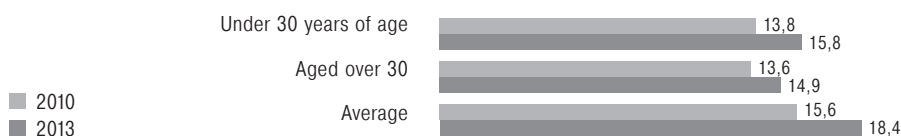
■ 2010
■ 2013

Table 5. **Percentage of workers covered by different types of CPE in 2010 and 2013**, Rosstat (%)

| Type of CPE | 2010 | 2013 |
|---|---|---|
| Continuing professional development | 6.8 | 7.6 |
| Continuing professional training or retraining (professional education in 2013) | 3.9 | 6.3 |
| Targeted training courses | 5.7 | N/A |
| Employer-funded professional education | 0.1 | 0.1 |
| Total workers covered | 15.8 | 13.8 |

targeted training courses, as this type of CPE was probably merged with professional education. Yet, the Rosstat methodology description provides no information on this change. The revealed increase in the percentage of workers covered by continuing professional development may also have to do with some specific aspects of calculation. In particular, the Rosstat methodology did not take into account continuing professional development of blue-collar workers in 2010, while the 2013 survey collected data on this type of CPE from all categories of workers.

**Conclusion**    For the last fewdecades, Russian and foreign researchers have been trying to systematize theoretical and empirical findings on continuing education, including CPE, but a consistent approach has not been developed so far. Hence the challenge: to choose the right indicators

in order to compare the rates of participation in continuing education as such and CPE in particular.

Analysis of statistical and sociological data reveals that percentages of workers covered by continuing education (including CPE) vary a lot across age cohorts and professional categories, and even more so across industries. Industry-specific characteristics of professional growth among Russian employees manifest themselves most strongly in the indices provided by Rosstat. In particular, over 20% of managers and specialists in healthcare and education engage in CPE annually thanks to government regulation of professional training processes in these industries. The CPE organization also has some specific features in telecommunications agencies, where semi-professionals tend to be the most covered category. Industry-specific characteristics of professional education should be considered when exploring the national CPE system.

Due to the data collection methods used by Rosstat, its indices do not present a true picture of CPE participation rates. Only large and medium-sized enterprises are covered by statistics, while the industries largely represented by small businesses are left underestimated. In addition, the official statistics are unable to embrace the diversity of CPE types and forms, so these problems should be solved through empirical studies.

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# Collective Co-Production in Russian Schools

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**Abstract.** The growing demand for quality education services together with the financial constraints faced by educational institutions produce the need for the active involvement of parents and other representatives of local communities in the educational process so as to provide schools with additional resources. As a form of such involvement, non-profit organizations (NPOs) can be established to support educational institutions. In this paper, we assess the level of collective co-production in Russian school education and look for correlations between institutional characteristics of schools and their cooperation with NPOs. The data for the research was obtained from the Unified State Register of Legal Entities (through the SPARK System), websites of local departments of education, and publicly available sources of information about activities of NPOs supporting schools. We reveal considerable cross-regional differences in the development of collective co-production in school education. The process is more active in provincial towns than in megalopolises: the proportion of schools supported by specifically founded NPOs is higher in many regional centers than in the capital cities. At the same time, a lot of regions have no such NPOs at all. As it turns out, NPOs are more likely to be created to support schools with a special status (gymnasiums, lyceums and specialized schools), where the parental demand for quality education services is higher. Meanwhile, we found no correlation between autonomous status of educational institutions and their participation in collective co-production. Thus, the increased degree of independence did not induce cooperation with NPOs for the purpose of raising extra-budgetary funds in this case.

**Keywords:** school, co-production, non-profit organization, demand for education services, autonomous educational institution, gymnasium, lyceum, specialized school.

The public sector has been interacting more and more with the private one over the last few decades. Various parties including nongovernmental organizations make their contribution in providing public services to the population. Management of such services often builds upon a long-term partnership of mutual responsibilities [Osborne 2010]. This interaction between citizens and government results in the development of co-production, i. e. engagement of con-

sumers in the delivery of public services. Collective co-production, which suggests involvement of citizen groups including non-profit organizations (NPOs), is gaining ground. Decades of research have shown that NPOs are among the most active co-producers today [Pestoff 2006].

This paper presents the results of empirical research on the process of co-production in school education. Co-production is not a new term for education: teacher-student interaction forms the basis of the learning process. Moreover, a specific feature of school education is that it requires the engagement of not only children as direct service recipients but their parents too. Today's development of the education sector also necessitates active participation of a wide range of citizens to fuel the process with additional resources, both financial and temporal [Ostrom 1996]. This necessity is largely due to the fact that public sector educational institutions are lagging behind the evolution of public needs and the severe financial constraints faced by the public sector all over the world. For this reason, many countries create and develop techniques of engaging citizens in the delivery of public services, education in particular [OECD2011]. This engagement may be individual or collective, when parents and other members of the public organize themselves to establish NPOs. The number of NPOs founded to support schools in the US increased from 3,500 in 1995 to 11,500 in 2010 [Nelson, Gazley 2014]. Funds that American schools receive from nonprofit organizations allow them to cope with the lack of public funding and increase the quality of educational services [Hansen et al. 2015].

The following questions are raised in the article:

1. What is the current level of collective co-production in Russian school education?
2. Is school interaction with NPOs affected by institutional characteristics of schools, such as status or type of business entity?

The object of research includes registered groups of school parents and other citizens—school boards, foundations, public and private nonprofit organizations—established to support and develop specific schools, as well as schools themselves.

The data for the research was obtained from the Unified State Register of Legal Entities (through the SPARK System), websites of local departments of education, and publicly available sources of information about activities of school-supporting NPOs.

**Co-Production: Basic Concepts**

In simple terms, "co-production" suggests the involvement of consumers in the creation of a public good. In this case, a public good is produced jointly by the "regular" producer, who creates a product for sale, and the "consumer" producer. The latter assumes some of the

production costs, thus becoming a co-producer, or a sort of partner for the professional producer [Ostrom 1996; Bovaird 2007]. Co-production provides an opportunity to increase product quality and productive efficiency [Kiser, Percy 1980; Parks et al. 1981]. Quality of services is often assessed subjectively, so the services sector is where consumer involvement can be of the most benefit to a higher quality. The co-production conception is most actively integrated into the public services sector, which is often non-market, financed by taxpayers, and governed by monopoly providers. The addition of service recipients' efforts to the work of paid officials or even substitution of the former for the latter is able to increase both the quality and the effectiveness of public services [Brudney, England 1983: 59]. Co-production can be additive or substituting: in the former case, the efforts of citizens and communities provide additional support to professional producers, while in the latter consumers perform some of the professionals' functions, including being involved in the provision of resources for production [Löffler, Watt 2010: 4].

An important benefit of co-production is the opportunity to reduce budget funds by means of attracting resources from service consumers. The cost–effectiveness ratio is improved when the volume and quality of services are preserved with lower budgetary costs or increase with the same amount of funding [Brudney 1984; Löffler, Watt 2010]. We believe that collective co-production provides the best opportunities for improving effectiveness in the public services sector.

The specific characteristics of public services shape the forms of co-production. National and local government institutions provide services that may have features of both private good, including significant positive externalities, and public good. There can be more than one direct consumer of such services, concerned about their quality and effectiveness. Besides, positive externalities of consuming educational or social services, for instance, may be a catalyst for citizen co-productive efforts. This way, a consumer of a service may participate in its creation by joining their efforts with other individuals interested in receiving this service or providing its adequate quality. For example, Bovaird regards not only service recipients but also volunteers and other members of local communities as co-producers [Bovaird 2007]. Consequently, there are also group co-production (joint efforts of a specific group of people or organization) and collective co-production (involving members of the whole community) [Kiser, Percy 1980; Rich 1981; Brudney, England 1983]. Group co-production may be organized informally or formally, in the form of registered nonprofit organizations [Sundeen, 1985].

**Collective Co-Production in School Education**

Specific aspects of education as a sector create conditions whereby co-production seems natural and justified [Parks et al. 1981; Pestoff, 2006; Porter 2012]. Quality education is clearly impossible if a

student does not invest any effort to digest new knowledge or acquire new skills and competencies. However, school education is a special case, because co-producers include not only students as direct consumers but also their representatives: parents, other relatives, or guardians. Engagement of most diverse community groups in co-production is made possible by the complex nature of educational services, which imply not only teaching, but also parenting and providing favorable conditions for these two processes. Despite not being professionals in this field, parents and other relatives can be engaged in the educational process, providing various components of it.

Studies demonstrate that parents assign a lot of importance to all of these components when assessing school effectiveness [Avraamova, Klyachko, Loginov 2014], which means they could be expected to invest their money and effort to improve the educational process. And because provision of educational services generates considerable external benefits, the quality of such services may be a matter of concern for other members of local communities. They are also consumers of this 'product' to some extent and are thus motivated to invest in the support of educational institutions, too.

Porter discriminates between required co-production—a student's proper effort—and contingent co-production—involvement of other participants, such as parents, peers, or local communities [Porter 2012: 151]. The latter type is optional, the level of effort and quality varying largely across communities. It may take an individual form, as in a contribution from individual parents, or a collective form, as when parents pool their resources for joint actions.

Just like in other sectors, collective forms of co-production in school education can be divided into informal—parent committees, which can be found in most schools, or school boards with no corporate status—and formal, i.e. registered NPOs. Internationally, there are different types of institutions providing support to schools in some way. Hansen and her colleagues made a list of various nongovernmental organizations providing private financing to public schools, including some specific ones: parent and alumni associations, booster clubs, school foundations, etc. [Hansen et al. 2015: 387].

First of all, such organizations provide financing to educational institutions. Besides, schools receive volunteer support and other donations from them [Ibid: 337]. "School-affiliated" NPOs facilitate the attraction of parental resources through collective agreements on the size of donations. While elaborating such agreements, these organizations arrive at negotiating the common objectives and building a consensus [Brunner, Sonstelie, 2003:2161]. Furthermore, Eric Brunner and Jon Sonstelie regard voluntary contributions and government revenue as commensurable sources of revenue, even though the latter are targeted for specific purposes [Ibid: 2162].

**Factors Affecting the Development of Collective Co-Production**

Apart from political and sociological theories, emergence of nongovernmental organizations is theoretically underpinned by economic theories of supply and demand.

According to the theories of supply (social entrepreneurship [Rose-Ackerman 1997], stakeholder control [Ben-Ner, van Hoomissen 1991]), citizens create NPOs on their own initiative, including for service provision purposes. This requires sufficient resources, i. e. an adequate standard of living and a relevant economic activity rate. Thus, for instance, the higher per-capita income and lower unemployment rate, the more chances of nonprofit emergence and the more schools can have "their own" nonprofits. Besides, an important role is played by the poverty threshold, which deters the development of nonprofits [Corbin 1999].

The theory of government failure explains the demand for services provided by nonprofits by the fact that public producers are not always able to meet citizens' requirements for both the volume and the quality of services. Nonprofits thus fill the emerging gaps [Weisbrod 1988]. Unmet demands in the quality and volume of educational services for their children inspires parents to invest additionally even in a relatively strong economic environment, let alone in a down economy [Nelson, Gazley 2014]. One research into the cooperation between American schools and their nonprofit partners has shown that the intensity of such interaction is influenced by both unsatisfied preferences about educational services, on the one hand, and financial and other resources required to establish nonprofit organizations, on the other hand [Paarlberg, Gen 2009].

In this study, we analyze the influence of demand-side factors on the development of collective co-production. We believe that Russian parents' need for a higher quality of educational services for their children is manifested in the pretty high demand for advanced types of schools, like gymnasiums, lyceums, or specialized schools. This being so, parents of students attending such educational institutions will more likely be involved in co-production by way of participating in activities of nonprofit organizations. Therefore, we expect that "status" schools will more often have affiliated nonprofit organizations.

Another demand-side factor that we believe affects the development of collective co-production is the school's type of business entity. Robert Bifulco and Helen F. Ladd investigated the engagement of American parents in school activities to find that the level of engagement was higher in charter schools than in regular public schools. This is explained by the small size of charter schools and some of their institutional characteristics, such as a higher degree of autonomy and the opportunity for parents to select such schools for their children [Bifulco, Ladd 2006]. Parts of some national and local public institutions in Russia have been granted autonomy since 2008, gaining more freedom "in disposing of the property made over to them and implementing the goals set before them and stipulated by the school

charter."[1] We suppose that this higher degree of independence from their founders should make autonomous schools more interested in attracting additional resources, particularly charitable contributions. Hence, we can presume that this type of business entity may act as a supplementary catalyst of intensive long-term interactions among school staff, parents and other members of local communities in the form of nonprofit organizations.

**Research Methods and Sampling**

We used the SPARK (Verification, analysis and monitoring of companies) system and websites of regional departments of education to analyze the level of collective co-production in secondary school. By the beginning of 2015, we had prepared two samples of institutions located in regional capitals: (i) registered nonprofit organizations affiliated with public specialized schools, lyceums and gymnasiums; (ii) schools of the abovementioned types. As for middle and elementary schools, progymnasiums, high schools, night, boarding, cadet and special schools, they were not included in order to provide a homogeneous sample. Because these types of educational institutions differ from specialized schools, lyceums and gymnasiums in terms of study, characteristics of student population, and specific aspects of the teaching and educating processes, we believe that parental attitudes towards providing consistent support to school may also be different. Accordingly, we did not consider the NPOs affiliated with those schools.

Homogeneity was also ensured by restricting the sample to regional capitals, which made it possible to draw more well-founded conclusions about the factors affecting the development of co-production in secondary school. In most regions, NPOs supporting specific schools are concentrated in the capital cities. It was only in Krasnodar Krai, Irkutsk Oblast and Kemerovo Oblast that the number of NPOs in regional capitals was lower than in the rest of the regional cities and towns put together.

The NPOs were sampled based on their names: we used indication of a specific school, gymnasium or lyceum in the nonprofit's name as a sampling criterion, leaving out institutions promoting education as a whole. This sampling strategy had a limitation: NPOs affiliated with schools but containing no relevant indication in their names probably fell off the radar. Activities of school-supporting NPOs were analyzed using the publicly available information on the web. A search among Perm organizations proved that information on NPOs is mainly presented in their pages on affiliated schools' websites.

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[1] Explanatory note to the draft of Federal Law "On Autonomous Institutions": http://asozd2.duma.gov.ru/arhiv/a_dz_4.nsf/BYID/3C2418F2105CDB-0F432571BB005C2180? OpenDocument

To find out whether NPOs were created more often to support schools of advanced types (specialized schools, gymnasiums and lyceums) and autonomous educational institutions, we used a chi-squared test, which allowed for comparing observed incidence rates with expected ones. We compared the number of schools supported by with the number of unsupported schools for "status" and autonomous educational institutions. In addition, we assessed the period of time between the date of gaining autonomy and the nonprofit registration date for the subsample of autonomous schools supported by nonprofits.

The total number of observations in all cities in the sample included 6,449 public educational institutions and 893 NPOs. Meanwhile, we found only 880 schools supported by NPOs. The reason for this discrepancy is that some educational institutions have two NPOs established in different years, according to the Unified State Register of Legal Entities. It can be two autonomous NPOs, two foundations, a foundation and a nonprofit, etc. This situation is most typical of Novosibirsk and Moscow. We believe that part of the formal organizations in fact are "hibernating" or out of business. As formal liquidation of NPOs comes at a price, it is sometimes easier to create a new organization, probably with new founders.

**Testing the Hypotheses on the Influence of School's Institutional Characteristics on Co-Production Development**

Foundations and nongovernmental organizations are the most widespread types of business entity for NPOs in Russia. Autonomous nonprofit organizations and voluntary associations are slightly less common. School boards, which Article 26 of Federal Law "On Education in the Russian Federation" defines as governing boards of educational institutions, are most often registered as NGOs or voluntary associations, less often as autonomous NPOs, and rarely as foundations.

Based upon what can be ascertained about the nonprofits' activities on their websites (e. g. extracts from their Charters), all of them aim to attract charitable funds and provide financial support to educational institutions. This support may include participation in the procurement of facilities and resources (purchasing supplies and equipment, expanding school libraries), ensuring a safe and comfortable learning environment (maintenance of school buildings and classrooms, financing of security guards), and arrangement of extracurricular activities. Many organizations provide various financial incentives for students: scholarships, prizes for competition winners and participants, etc. Another activity of a number of NPOs is involvement in the organization of the learning process as such (engaging parents in their children's school life, negotiating elective courses with school administrators) and even in school administration (distributing incentive bonuses for teachers).

The proportion of schools supported by NPOs in the capital cities varies significantly from region to region (Fig. 1). Such institutions

Figure 1. **Proportion of schools supported by NPOs in Russian regional capitals** (%)

| City | % |
|------|------|
| Penza | 81,0 |
| Ulan-Ude | 59,6 |
| Novosibirsk | 59,4 |
| Kirov | 58,8 |
| Orenburg | 58,7 |
| Omsk | 53,7 |
| Saratov | 43,3 |
| Tver | 35,3 |
| Nizhny Novgorod | 35,2 |
| Izhevsk | 31,3 |
| Krasnoyarsk | 25,7 |
| Perm | 25,4 |
| Kazan | 25,0 |
| Yakutsk | 24,4 |
| Abakan | 23,8 |
| Ulyanovsk | 21,6 |
| Yuzhno-Sakhalinsk | 20,8 |
| Kursk | 20,0 |
| Yekaterinburg | 17,8 |
| Magadan | 17,6 |
| Lipetsk | 15,8 |
| Ufa | 11,9 |
| Chita | 11,1 |
| Astrakhan | 10,9 |
| Vologda | 10,8 |
| Moscow | 10,0 |
| Barnaul | 9,9 |
| Vladivostok | 9,2 |
| Irkutsk | 9,0 |
| Kostroma | 8,6 |
| Chelyabinsk | 8,5 |
| Kemerovo | 6,7 |
| Krasnodar | 6,0 |
| Samara | 5,4 |
| Cheboksary | 5,4 |
| Stavropol | 5,1 |
| Blagoveshchensk | 5,0 |
| Rostov-on-Don | 4,9 |
| Saint Petersburg | 4,8 |
| Kaluga | 4,3 |
| Kaliningrad | 4,3 |
| Tyumen | 4,1 |
| Yaroslavl | 4,1 |
| Voronezh | 3,7 |
| Yoshkar-Ola | 3,6 |
| Khabarovsk | 2,8 |
| Petrozavodsk | 2,7 |
| Belgorod | 2,5 |
| Vladikavkaz | 2,5 |
| Ivanovo | 1,9 |
| Makhachkala | 1,8 |
| Tomsk | 1,8 |
| Bryansk | 1,6 |
| Volgograd | 1,6 |
| Anadyr | 0,0 |
| Arkhangelsk | 0,0 |
| Birobidzhan | 0,0 |
| Vladimir | 0,0 |
| Gorno-Altaysk | 0,0 |
| Grozny | 0,0 |
| Kurgan | 0,0 |
| Kyzyl | 0,0 |
| Maykop | 0,0 |
| Murmansk | 0,0 |
| Nalchik | 0,0 |
| Novgorod | 0,0 |
| Orel | 0,0 |
| Petropavlovsk | 0,0 |
| Pskov | 0,0 |
| Ryazan | 0,0 |
| Saransk | 0,0 |
| Smolensk | 0,0 |
| Syktyvkar | 0,0 |
| Tambov | 0,0 |
| Tula | 0,0 |
| Elista | 0,0 |

*Source:*
SPARK: http://www.spark-interfax.ru/; official websites of local departments of education.

Table 1. **Regional differences in the proportion of schools officially supported by NPOs**

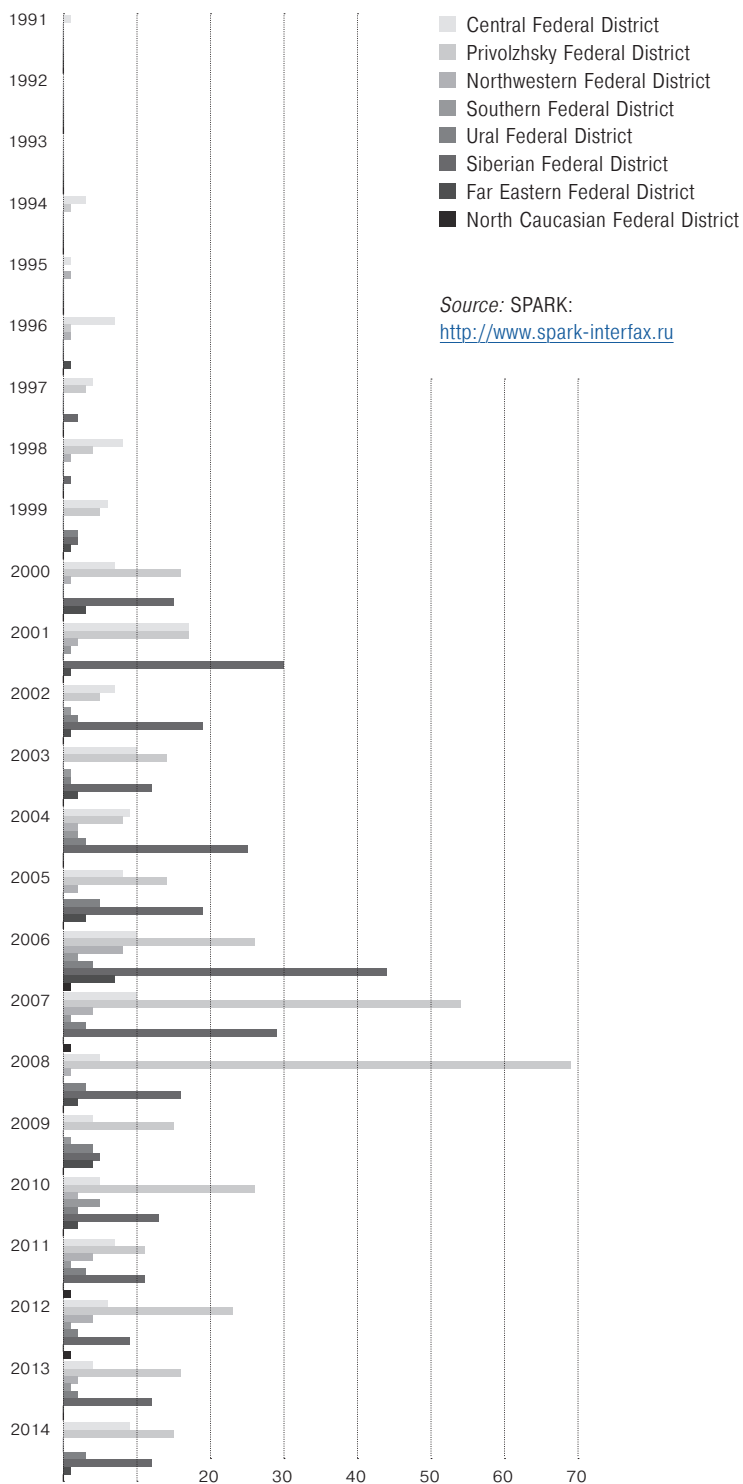| Federal district | Mean | Median | Coefficient of variation (%) |
|---|---|---|---|
| Central | 6.1 | 2.5 | 154.0 |
| North West | 2.7 | 0 | 141.8 |
| Volga | 28.7 | 23.3 | 84.7 |
| Ural | 7.6 | 6.3 | 100.5 |
| South | 3.9 | 3.2 | 109.4 |
| Northern Caucasus | 1.3 | 0 | 145.8 |
| Siberia | 21.7 | 10.5 | 106.5 |
| Far East | 9.2 | 5 | 110.7 |

Source: SPARK: http://www.spark-interfax.ru/; official websites of local departments of education.

are a feature of 54 regional capitals only, according to the Unified State Register of Legal Entities, being confined to the capitals in most regions. The maximum absolute number of schools in cooperation with NPOs was revealed in Novosibirsk (107), followed by Moscow (86), with Saint Petersburg ranked as low as 15th place (27).

A comparison of data across federal districts reveals considerable gaps both within the districts and between them (Table 1). The Privolzhsky (Volga) and Siberian Federal Districts boast the highest proportions of schools supported by NPOs. Thirteen of the 15 cities with the highest absolute number of such educational institutions are regional capitals of these districts. Coefficient of variation (CV) of the proportion of such schools determines the degree of difference among cities and towns within the same district. The CV is extremely high in all districts (several times higher than the threshold value of 33.3%: when it is exceeded, the sample cannot be considered homogeneous), which means that our samples are highly heterogeneous. The lowest CV was found in the Privolzhsky Federal District: the proportion of schools supported by NPOs is the least dispersed there, i. e. there are fewer differences between the cities than in other districts. The Central Federal District is the most heterogeneous of all in this regard, combining relatively high proportions of schools supported by NPOs in some of the regions with zero values in six regions.

As we systematized the information on nonprofit registration dates, we found out that the very first school-supporting organizations had emerged in the early 1990s (the earliest nonprofit in the sample was registered in Moscow in 1991), and most of them were established in the 2000s (Fig. 2), with the peaks in 2006, 2007 and 2008 (102, 102

Figure 2. **Dynamics of nonprofit registration**



Central Federal District
Privolzhsky Federal District
Northwestern Federal District
Southern Federal District
Ural Federal District
Siberian Federal District
Far Eastern Federal District
North Caucasian Federal District

*Source:* SPARK:
http://www.spark-interfax.ru

Table 2. **Incidence of NPOs affiliated with "status" and autonomous schools, compared with the incidence of NPOs supporting schools of other types**

| | | Gymnasiums, lyceums, specialized schools | Other types of secondary schools | Autonomous schools | State-owned educational institutions |
|---|---|---|---|---|---|
| Privolzhsky FD | Schools supported by NPOs | 181 | 166 | 71 | 276 |
| | Other schools | 275 | 621 | 132 | 764 |
| | χ² test | 49.64 | | 6.01 | |
| | *p*-value | 0.000 | | 0.014 | |
| Central FD | Schools supported by NPOs | 75 | 64 | 4 | 135 |
| | Other schools | 399 | 1616 | 46 | 1969 |
| | χ² test | 88.38 | | 0.203 | |
| | *p*-value | 0.000 | | 0.652 | |
| Siberian FD | Schools supported by NPOs | 104 | 165 | 40 | 229 |
| | Other schools | 124 | 452 | 82 | 494 |
| | χ² test | 27.32 | | 0.06 | |
| | *p*-value | 0.000 | | 0.807 | |
| Northwestern FD | Schools supported by NPOs | 21 | 11 | 3 | 29 |
| | Other schools | 318 | 527 | 98 | 747 |
| | χ² test | 10.19 | | 0.15 | |
| | *p*-value | 0.001 | | 0.699 | |
| Far Eastern FD | Schools supported by NPOs | 23 | 6 | 7 | 22 |
| | Other schools | 56 | 199 | 32 | 223 |
| | χ² test | 42.65 | | 2.95 | |
| | *p*-value | 0.000 | | 0.086 | |
| Ural FD | Schools supported by NPOs | 26 | 17 | 16 | 27 |
| | Other schools | 77 | 279 | 159 | 197 |
| | χ² test | 30.22 | | 0.87 | |
| | *p*-value | 0.000 | | 0.352 | |
| Southern FD | Schools supported by NPOs | 9 | 8 | 1 | 16 |
| | Other schools | 88 | 299 | 19 | 368 |
| | χ² test | 8.14 | | 0.03 | |
| | *p*-value | 0.004 | | 0.856 | |
| North Caucasian FD | Schools supported by NPOs | 4 | 0 | 0 | 4 |
| | Other schools | 71 | 168 | 3 | 236 |
| | χ² test | 9.11 | | 0.05 | |
| | *p*-value | 0.003 | | 0.822 | |

*Source:* SPARK: http://www.spark-interfax.ru/; official websites of local departments of education.

and 96 NPOs, respectively). At the same time, the dynamics of non-profit registration differs a lot across federal districts. The largest number of school-supporting NPOs was registered in 2001 in the Central Federal District, in 2008 in Volga, and in 2006 in Siberia.

Correlations between NPOs in co-production and demand-side factors were analyzed using subsamples of specific federal districts. We used a chi-squared test to compare the incidence of NPOs affiliated with "status" and autonomous schools with the incidence of NPOs supporting other types of schools (Table 2). In all districts, NPOs were created more often to support gymnasiums, lyceums and specialized schools, which confirms our hypothesis. As for correlations between NPOs and the type of business entity, it was only in the Privolzhsky District that autonomous institutions proved to be supported by NPOs more often than other schools. Otherwise, no relationship between school autonomy and support from NPOs was revealed even in Ural, where autonomous schools account for a little less than half of all secondary education institutions (44%).

Bearing in mind that schools can have autonomy and an advanced status at the same time, we analyzed the resulting data again to shed more light on the relationship between the type of business entity and affiliation with a nonprofit organization. In our sample, 713 educational institutions (11% of the sample) are autonomous, of which only 142 (20%) are supported by affiliated NPOs. Analysis of the dates of registration and obtaining autonomy showed that NPOs had been created before schools were granted autonomy in the majority (83%) of cases (although the interval did not exceed one or two months in four cases). Of these 142 autonomous institutions supported (at least formally) by NPOs, 101 qualify as gymnasiums, lyceums or specialized schools, and only 41 as "regular" schools. In the latter group, only nine schools became autonomous before any affiliated NGO, voluntary association or foundation was registered to support them. This allows us to conclude that changes in the type of business entity were not a catalyst of public support formalization and institutionalization.

**Conclusion**  Analysis of the constitutional documents of school-supporting NPOs shows that one of their goals is the partial substitution of their own and their raised funds for public funding: co-producers assume defraying part of the maintenance and procurement expenses. Thus, NPOs combine additive and substituting co-production.

Collective co-production in school education develops unevenly in different regions of Russia. The process is relatively more active in provincial towns: the proportion of schools supported by specifically founded NPOs is higher in many regional centers than in the capital cities, the highest being in the Privolzhsky and Siberian Federal Districts. Perhaps, the reason for this is the more acute need of provincial educational institutions for extrabudgetary funds. In a number of

regions, this type of co-production remains at the level of informal organizations, such as parental committees or school boards that are not registered as legal entities. NPOs exist in only three regions of the Northern Caucasus (four organizations). Such geographical distribution may have to do with institutional conditions—like availability of an adequate environment for the third sector development—and with the regional level of socioeconomic development.

As judged by the dynamics of registration of school-supporting NPOs, the snowballing phase is over for this segment of the Russian nonprofit sector. The overall number of new school-supporting NPOs has been decreasing annually in Russia since 2009, and affiliated schools account for as little as 13.6% of the total number of sampled secondary schools in regional capitals. Again, the reasons are likely to be found in regional institutional conditions, such as the attitude of education authorities toward increasing the engagement of parents and other community members in schools' activities.

We have seen that NPOs are more often created to support secondary schools of advanced types (gymnasiums, lyceums, and specialized schools). It validates our hypothesis that a higher parental demand for quality educational services will promote formal collective co-production. Meanwhile, the absence of any correlation between school autonomy and school participation in such co-production demonstrates, to our mind, that these educational institutions do not use their full potential in attracting non-budgetary funds and other public resources.

We believe that creation of nonprofit organizations may be inhibited by the attitude of school administrators. Studies show that some school principals have an authoritarian leadership style, preventing any meaningful engagement with parents or other community members [Farkhatdinov et al. 2015]. In addition, the decision about creating a nonprofit organization can be affected by perceived costs of formal registration (the need to open a bank account, register an organization with the statistical authorities, the local tax office, and the Ministry of Justice, etc.) and accounting (bookkeeping, financial reporting).

We should admit that our research had a limitation: it did not control the actual activities of NPOs, only the fact of their formal registration. The studies on activities of Russian NPOs conducted by the Center for Studies of Civil Society and the Nonprofit Sector of the Higher school of Economics demonstrate that genuinely functioning NPOs are much less numerous than formal ones in Russia [Mersiyanova, Yakobson 2007; Mersiyanova, Korneeva 2011]. Some of them are "hibernating", while others never engaged in any activity after registration. Nevertheless, the very creation of nonprofit organizations can be regarded as an intention of proactive parents to participate in co-production. As for the level of co-production in the cities of Russia, we believe that our findings can serve as the basis for a compar-

ative analysis in order to identify the differences and investigate the reasons behind them.

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# New Trends in School Education Development

## Based on the Annual Monitoring Research Conducted by the Center of Economy of Continuous Education of the Presidential Academy of National Economy and Public Administration (RANEPA)

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**Abstract.** We analyze results from the fourth wave of the annual monitoring of school effectiveness, conducted by the Center of Economy of Continuous Education of the Presidential Academy of National Economy and Public Administration (RANEPA) since the academic year 2012/13. Based on a survey of school principals, teachers and parents, we build quite a holistic picture of school education evolution and changes to its components, such as the staffing of schools, teaching quality, as well as professionalism, salaries and social positions of teachers. The development of the school education system from the perspective of principals and teachers is compared to the parental requirements for school education. We also show the effects of the economic downturn on education, in particular the cuts to school funding. Teachers report a decrease in their salaries. Egalitarian distribution of incentive bonuses has given way to a higher differentiation in teachers' pay, which can be regarded as a positive effect of the efficient contract. The reduced effective demand for supplementary educational services entails a decline in extrabudgetary revenues. There has been a perceptible decrease in the territorial differentiation in teacher remuneration, teacher engagement in advanced training programs, and the quality of education as such. At the same time, regional differentiation is growing. The chain of transformations launched by the remuneration reform has rejuvenated the staff composition of Russian schools, enhanced the quality of the teaching staff, and contributed to better interaction between teachers and other school education actors, but the effect on the quality of graduates has yet to be revealed.

**Keywords:** school, school education, payment of teachers, training of teachers, staffing of schools, education quality assessment.

**Problem setting and information basis**

The article presents some results from the fourth wave of the monitoring of school education effectiveness conducted by the Center of Economy of Continuous Education of the Presidential Academy of National Economy and Public Administration (RANEPA). All of the monitoring waves are conducted using the same methodology developed by the authors and tested during the first wave (academic year 2012/13). The basic methodological principle of this study is to use a few categories of respondents—principals, teachers, and parents—as a source of information, instead of just one homogeneous category. By doing so, we analyze information obtained from respondents representing all the main types of school education actors, thus we are able to draw quite a holistic picture.

The information basis of research is the survey data collected from households with school-aged children and school teachers (2,100 respondents in each target group), complemented with school principals' opinions obtained in 40 in-depth interviews. The surveys were conducted in four regions of Russia differing in socioeconomic development: Chelyabinsk Oblast, Stavropol Krai, Altai Krai, and Saint Petersburg. Respondents were drawn from a multistage random sample covering the population of the regional capitalsas well as urban and rural localities of the selected regions (25 surveyed locations) and ensuredthe representativeness of the obtained sociological data (statistical error does not exceed 4%).

The universal methodology used in each wave of the monitoring, however, does not rule out certain variations in the questionnaires. Each individual wave includes questions required to obtain information on emerging problems and any issues that become the focus of public attention or arouse the interest of researchers.

The following aspects are always included in the monitoring: school staffing, teaching staff rejuvenation, quality of teaching, school financing, teacher pay, and development of extracurricular education. Researchers also analyze the changes in parental requirements for school education; in particular, this is addressed by Avraamova, Klyachko, Loginov [2014]. Apart from these constant elements, the fourth wave also deals with two specific issues: (i) how the teacher remuneration system has changed, and the consumption of educational services in a down economy; and (ii) which qualitative characteristics of education have been affected by the teacher remuneration reform.

**Beliefs about education value and accessibility**

Most of the parents surveyed agree that a child should attend a good school in order to obtain a quality professional education in the future. Approximately the same percentage of respondents believe that children need supplemental courses even if they attend a good school.

The financial standing of a family affects the choice of school (in this study, the notion of "good" schools covers specialized schools,

Table 1. **Types of schools attended by children from families with different financial standings** (% summed up row-wise)

| Financial standing | Type of school | |
|---|---|---|
| | Regular | Specialized school / gymnasium / lyceum |
| Above average | 69.6 | 30.4 |
| Average | 79.2 | 20.8 |
| Below average | 85.0 | 15.0 |
| Total | 79.4 | 20.6 |

Table 2. **Types of schools attended by children from families with different parental education statuses** (% summed up row-wise)

| Parental education | Type of school | |
|---|---|---|
| | Regular | Specialized school / gymnasium / lyceum |
| Both parents have a higher education degree | 64.5 | 35.5 |
| Only one of the parents has a higher education degree | 79.4 | 20.6 |
| None of the parents has a higher education degree | 89.7 | 10.3 |
| Total | 79.4 | 20.6 |

gymnasiums and lyceums)[1] (Table 1). The higher the family income, the more likely a child will attend a specialized school, gymnasium or lyceum. These findings are important as they allow us to see how effectively the general education system meets its fundamental challenge of expanding access to high-quality education. Some positive trends can be observed here: the percentage of children from low-income families attending specialized schools has increased by 5.6% as compared to the first wave findings.

There are research findings [Konstantinovsky, Popova 2016] demonstrating that a family's beliefs about education are shaped by its place of residence and socioeconomic status. Judging from the

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[1]  Financial standing was determined based on respondents' subjective assessments.

Table 3. **Types of preschool experience** (% summed up column-wise)

| Type of preschool experience | |
|---|---|
| No preschool education | 3.2 |
| Attending a kindergarten offering no preschool or early childhood development programs | 23.7 |
| Attending kindergarten-based preschool courses | 12.2 |
| Attending kindergarten-based preschool courses and engaging in other preschool or early childhood development programs | 59.9 |

monitoring data, family status retains its importance as a factor determining beliefs about education value and accessibility, while place of residence is gradually losing ground, as illustrated below.

Other factors affecting the choice of school, important from the perspective of social reproduction, include the education and social self-identification of parents. The higher the education level of parents, the more likely a child will get enrolled in a good school (Table 2).

There is no obvious difference in the choice of school between households identifying their financial standing as "above average" and "average", but those defining themselves as "below average" are definitely less particular about education quality, more so for the underclass. Therefore, school still plays the role of a social reproduction mechanism, but the underclass is getting ever more access to quality education.

As more and more parents understand the importance of choosing the right kind of school, most children tend to engage in preschool courses (Table 3), and many even engage in various types of preschool education. Preschool education is most intensively pursued by children who apply for specialized schools, which means that complex and varied educational trajectories start early, at the preschool age.

The choice of school made by parents of preschool children is rarely revised later: only 9% of children changed their school for different reasons. Particular loyalty to preselected schools is demonstrated by parents of children attending specialized schools.

**Educational intentions**

The educational intentions of school students have been widely studied and covered by researchers [Konstantinovsky et al. 2015:123–184; Avraamova, Loginov 2014; Abankina, Krasilova, Yastrebov 2012]. However, the fourth wave of the monitoring revealed a certain decrease in the trend where the vast majority of children progressed or intended to progress from Grade 9 to Grade 10 with a view to obtaining higher education in the long run (Fig. 1). According to the most recent official figures, the relevant indicator has dropped by almost 7%.

Figure 1. **Intentions of parents concerning the education of their children after Grade 9** (as a percentage of the overall number of respondents whose children study in Grades 1–9)



Have not yet decided, 43,7

Progress to Grade 10, 42,8

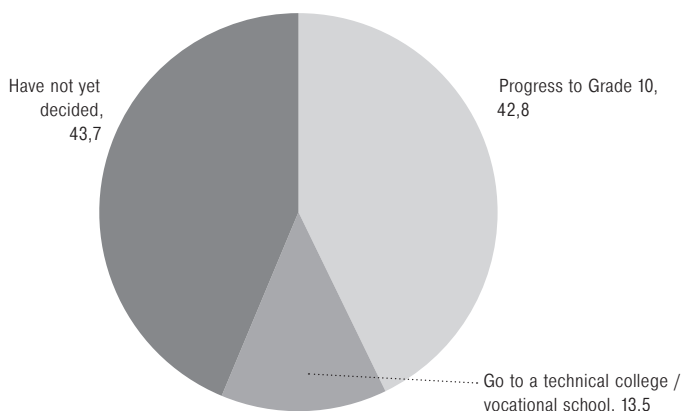Go to a technical college / vocational school, 13,5

Table 4. **Intentions of parents concerning the education of their children after Grade 9 depending on the type of locality** (% of the number of respondents whose children study in Grades 1–9, summed up row-wise)

| Type of locality | Intended educational trajectories after Grade 9 | | |
| --- | --- | --- | --- |
| | Progress to Grade 10 | Go to a technical college / vocational school | Have not yet decided |
| Regional capital | 48.2 | 11.6 | 40.2 |
| City | 39.1 | 12.1 | 48.8 |
| Rural settlement | 42.1 | 16.7 | 41.2 |
| Total | 42.8 | 13.5 | 43.7 |

There is almost no difference in parental intentions to send their children to high school depending on the region and type of locality, except that parents in the regional capitals are slightly more committed to providing high school education to their children (6% higher than the average value). Meanwhile, the intentions of rural families differ little from those of parents in municipalities (Table 4).

The intention to progress to high school is determined by the family's financial standing (Table 5): the higher the family income, the more likely parents are to send their children on to Grade 10. At the same time, only 50% of families with an above average income made a firm decision about it (the relevant indicator being considerably lower in other income categories), which can be regarded as an indirect indicator of decreased higher education orientation.

Table 5. **Intentions of parents concerning the education of their children after Grade 9 depending on the family's financial standing** (% of the number of respondents whose children study in Grades 1–9, summed up row-wise)

| Financial standing | Intended educational trajectories after Grade 9 | | |
|---|---|---|---|
| | Progress to Grade 10 | Go to a technical college / vocational school | Have not yet decided |
| Above average | 50.7 | 12.2 | 37.1 |
| Average | 43.4 | 12.0 | 44.6 |
| Below average | 36.8 | 18.8 | 44.4 |
| Total | 42.8 | 13.5 | 43.7 |

The research findings show that the value of higher education is unshakable in the minds of school students' parents: 85% of respondents are convinced that higher education is a must, regardless of whether they live in a regional capital, municipality, or rural settlement. However, actual intentions are not really in line with those declarations.

**The need for supplemental courses for schoolchildren**

Many parents are committed to sending their children to a university and thus want them to score better in the final ninth-grade examinations. Meanwhile, 53% of parents surveyed are convinced that high scores are hard to achieve without supplemental courses. The higher the family income, the higher the percentage of children attending fee-based supplemental courses.

As a rule, specialized schools provide a wider choice of fee-based educational services (Table 6). This way, they benefit not only from more complex education programs but also from attracting households with higher levels of effective demand.

The parent surveys show that supplemental courses are mostly needed to provide for further educational intentions rather than to achieve better outcomes at school. As children progress from elementary to high school, the incidence of reporting sports and arts as extracurricular activities drops from 20% to 2% and from 42% to 7%, respectively, and successful performance in the final examinations comes to the foreground.

Economic downturns may change parental intentions to continue providing children with the opportunity to attend supplemental courses in the future. Only 7.5% of parent respondents report being unaffected by the negative economic trends, with 85% being affected to some extent. Only 40% of parents are convinced that they won't have to change the intended educational trajectories of their children.

Table 6. **Fee-based supplemental courses in different types of schools** (% summed up row-wise)

| Type of school | Fee-based supplemental courses | | | |
| --- | --- | --- | --- | --- |
| | Wide choice | Narrow choice | None | No answer |
| Regular school | 5.9 | 15.8 | 48.6 | 29.7 |
| Specialized school / gymnasium / lyceum | 17.8 | 26.1 | 27.0 | 29.1 |
| Total | 8.4 | 17.9 | 44.2 | 29.5 |

Table 7. **Parental beliefs about the importance of specific school education objectives** (% summed up row-wise)

| School education objectives | Degree of importance | | | |
| --- | --- | --- | --- | --- |
| | Very important | Quite important | Of little importance | Not important at all |
| Obtaining knowledge required for building a specific career in the future | | | | |
| 2015 | 65.8 | 26.0 | 5.5 | 2.7 |
| 2016 | 72.1 | 23.5 | 3.7 | 0.7 |
| Obtaining diverse knowledge expanding the world vision and giving the right to be called an educated person | | | | |
| 2015 | 63.3 | 33.4 | 2.7 | 0.6 |
| 2016 | 69.6 | 28.1 | 1.8 | 0.5 |
| Inculcating self-discipline, diligence, and rules of conduct in children | | | | |
| 2015 | 68.6 | 28.7 | 2.4 | 0.3 |
| 2016 | 70.6 | 26.1 | 2.7 | 0.6 |
| Inclusion in sports, arts and tourism | | | | |
| 2015 | 52.2 | 37.6 | 9.1 | 1.1 |
| 2016 | 51.4 | 39.1 | 8.7 | 0.8 |
| Learning to communicate with peers and teachers | | | | |
| 2015 | 64.3 | 33.0 | 2.3 | 0.4 |
| 2016 | 68.5 | 28.6 | 2.5 | 0.4 |

**Parental requirements for higher education**

Having compared the findings of the last two waves of the monitoring, we can say that parents tend to understand the importance of school objectives better: each of the objectives, except sports inclusion, is believed to be very important by more parents than last year (Table 7).

As with last year's monitoring, most parents insist on the importance of all the specified objectives instead of accentuating only one or two, and only slightly prioritize obtaining knowledge as such over

the other objectives. The idea of school as a universal institution providing not only education but also the socialization of children may be considered a social norm, being shared by the overwhelming majority of parents, notwithstanding their level of education, place of residence or financial standing.

Based on the data we obtained about the inclusion of parents in the learning process and the high consumption of supplemental educational services, we can suggest that parents have mastered, together with schools, the mechanism of achieving the paramount objective of obtaining the necessary knowledge. Meanwhile, they find it a challenge to support the other objectives, so they just bring them entirely under the control of schools.

**What principals think about the changes in school education**

Modern schools operate in the context of ongoing reforms, which makes it difficult to provide an effective response to parental demands. School principals believe that the core school education content should remain unchanged, yet keep up with technology development. The main changes to the learning process should be associated with the teaching methods and techniques, considering the wide distribution of new information technology. Information technology has become engrained in teaching practices: teachers use online journals and diaries, include IT technology in the learning process, set up webinars, etc. Distance education is available in nearly every school and is usually provided to students who are unable to attend school with their peers due to health issues, family reasons, etc.

All the principals agree that changes to the school system—whether content- or form-related—should be introduced very carefully, step by step, to prevent any wreckage of established traditions.

**School effectiveness**

When discussing school effectiveness, all the principals emphasize that it cannot be assessed based on one or two criteria or formal indicators only. Apart from the rankings, most school principals assign a lot of importance to the school climate, its traditions, and teacher-student and teacher-parent relationships. The success of graduates is measured by the level of their social adaptation and integration. Effective schools build long-term relationships with students. They are often perceived as comfortable for learning, having been attended by several generations of the same families. The effectiveness of regional schools is largely determined by the percentage of the school's graduates in the teaching staff.

Principals believe that school effectiveness is shaped by external and internal factors. Schools cannot influence the external factors of financing and material resources, and the trends are universally believed to be mostly negative: schools have been underfunded in recent years, and most principals do not expect any change for the

better in the near future. However, schools are able to work on internal factors, which should form the foundation of their development. These include teaching staff, teaching quality, professionalism and open-mindedness of teachers, as well as efforts to engage parents in solving school problems. Some principals tend to associate the positive trends in the development of internal school effectiveness factors with the creation of parent councils and school boards.

**School staffing**

The staffing situation in St. Petersburg schools differs from those in other regions. St. Petersburg schools experience virtually no problems with filling vacancies, and if they ever have any, such problems are always easy to solve. In contrast, other regions continuously suffer from a blatant staff scarcity. There is usually a shortage of subject-specific teachers (mathematics, geography and physics were mentioned most often). At the same time, some positive trends in school staff rejuvenation are emerging: the modal age interval is 40–45 years today, as compared to 45–50 in the first wave. Teachers of 20% of schools surveyed report a significant staff turnover.

School principals are normally happy with their teaching staff and are not eager to make any transformations. All the principals assess their teachers as having high levels of competencies and claim to be willing to work with both senior and younger professionals, although seasoned employees are obviously preferred in terms of reliability and qualifications.

**Quality of teaching**

The fourth wave of the monitoring shows a reinforcement of the trends revealed at the previous stages. These include, first of all, the leveling of the quality of teaching between regular and specialized schools. The second major trend is that teachers, upon their own statements, expand their competencies, paying more attention not only to lesson planning but also to out-of-school activities. Thirdly, teachers have now adopted new forms of teaching based on using IT technology.

However, the shifts in the quality of teaching described above have not increased the overall performance level, which has only grown in SFE-9[2] ad USE[3] subjects. And even this subject-specific improvement can hardly be accredited to school alone, because, as teachers believe, only supplemental courses can guarantee high examination scores.

The lack of direct correspondence between final exam requirements and school education quality assessment criteria is realized by school administrators, becoming a driver of regular chang-

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[2] State final examinations for ninth-graders

[3] Unified State Exam

es to the final test procedures. Not only do these changes produce a psychological stress for students and their parents, but this is also a stress for school administrators, because adjusting to new final test requirements distracts teachers from actually teaching, thus decreasing the teaching quality. Therefore, SFE-9 and USE scores cannot be considered as a formal indicator of education quality.

Teachers in the regional capitals assess the quality of teaching more critically than their rural and municipality colleagues. Most probably, this tendency indicates a higher level of self-exigency of metropolitan schools rather than a higher quality of teaching in rural and municipality institutions.

There is an inverse relationship between the quality of teaching and the degree of teaching staff turnover. Schools that had had little or no employee turnover were more likely to have strong teaching teams, while teachers in schools with a significant staff turnover tended to give more conservative teaching quality assessments. We can assume that it must be the case that the strong teaching teams simply did not require any transformation. Anyway, a significant staff turnover cannot be unequivocally interpreted as a prerequisite for enhancing the quality of teaching.

**Increasing teacher requirements**

Teachers are unanimous in their opinions on the ever-increasing requirements to teaching quality imposed by school administrators, whatever the type of school (regular or specialized). While the requirements are universal as such, the increase mostly affects teachers who find meeting those requirements more difficult than others (e. g. rural teachers).

On the whole, teachers are receptive to these changes, believing that high teaching quality and classroom management requirements are "objective law" under the existing conditions (Fig. 2). Besides, teachers understand that school administrators feel pressure fromthe higher-level education authorities.

There is direct relationship between school administrators' requirements and teaching staff reinforcement: the school teams that became stronger, as believed by the teachers themselves, had experienced a greater increase in the teaching quality requirements imposed by school administrators.

More than half of teacher respondents also report an increase in the requirements imposed by parents of school students (Fig. 3).

The percentage of teachers who believe that bureaucratic requirements have also increased is nearly the same as the percentage of those who reported an increase in teaching quality requirements. However, increased quality requirements reinforce the teaching staff, which is out of the question in the case of bureaucratic requirements.

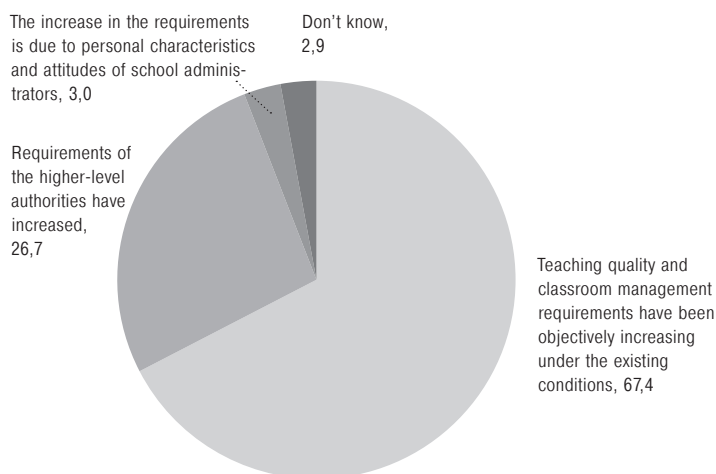Figure 2. **Reasons for school administrators increasing teacher requirements, as perceived by teachers** (%)

The increase in the requirements is due to personal characteristics and attitudes of school administrators, 3,0

Don't know, 2,9

Requirements of the higher-level authorities have increased, 26,7

Teaching quality and classroom management requirements have been objectively increasing under the existing conditions, 67,4

Figure 3. **How parental requirements for the quality of teaching have changed, according to teachers** (%)

Don't know, 6,4

Parental requirements have decreased, 5,9

Parental requirements have increased, 53,5

Parental requirements haven't changed 34,2
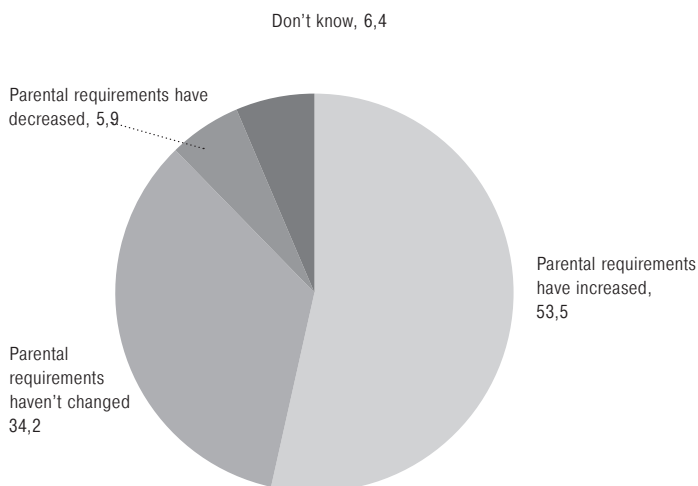
**Teacher professionalism**
Russian teachers upgrade their skills actively: only 3.9% of school teachers have not engaged in continuing professional education programs in the previous three years.

Continuing professional education courses offered by specialized further education institutions are considered by teachers to be the most effective. Relevant programs provided by pedagogical universities are ranked second. Continuing education realized in the form

of a mentorship at the same school or advanced programs offered by other schools as part of inter-school cooperation are not classified by teachers as effective forms of continuing education (as pointed out by less than 10% respondents).

Sixteen percent of teachers attach so much importance to engaging in continuing professional education that they are ready to pay for it out of their own pockets, if necessary. Another one-third of respondents claim to be ready to consider such an option. However, half of teacher respondents do not agree with paying for advanced training courses.

Teachers can enhance their skills by attending courses offered by either third-party educational institutions (outside continuing education) or their own school (in-house training). Outside education courses can be of different types:

- Courses in specific subjects (for teachers teaching those subjects);
- Courses in methodology of teaching (e. g. in Federal State Education Standard integration);
- Courses designed to improve technology literacy and train teachers to use modern devices.

In-house training is a widespread way of continuing professional education. It is delivered in the form of seminars (both intra-school and inter-school), exchange of experience, and mentorship programs. Principals find it important that they are free to determine the content of such advanced training programs.

School principals believe that continuing education programs are not infallible, as they do not always give teachers the knowledge they really need and are usually off-the-job. In regional schools, the lack of teachers during such training periods leadsto severe problems, given the scarcity of staff. For this reason, most principals are hostile to the looming introduction of annual advanced trainings for teachers. At the same time, the majority of school principals point out the positive effects of such programs as well as the improvements in the quality of teaching over the recent years.

The most demanded topics in advanced training courses are related to psychological techniques of teaching students, especially those with disabilities.

**Teacher remuneration**

An increase in teachers' pay has been the focus of public attention over recent years, making up part of the Russian President's package of inaugural decrees. The incentive was supposed to promote the effectiveness of school education [Abankina 2009].

The fourth wave of the monitoring reveals cuts in public school funding at the level of expenses for repair, equipment, supplies, and
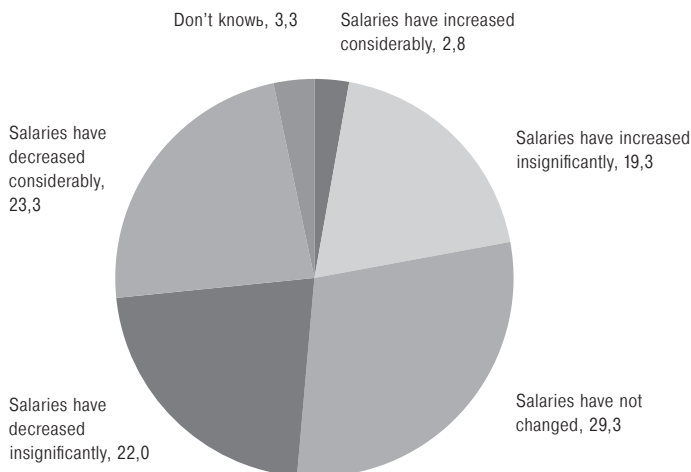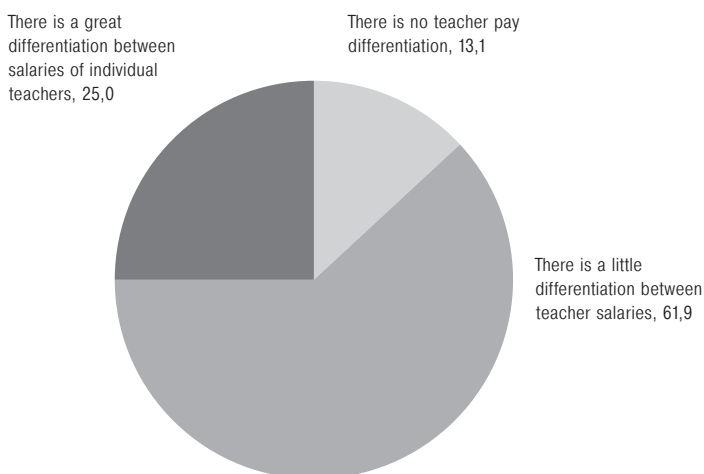
Figure 4. **Perceived teacher pay dynamics** (%)



Table 8. **The perceived dynamics of teacher salaries across different teacher categories** (% summed up column-wise)

| Salaries | Teacher category | | |
|---|---|---|---|
| | Top category | Category 1 | Category 2 / No category |
| Have increased considerably | 2.1 | 2.4 | 5.2 |
| Have increased insignificantly | 15.1 | 23.9 | 23.8 |
| Have not changed | 33.2 | 27.7 | 21.1 |
| Have decreased insignificantly | 23.5 | 21.8 | 18.3 |
| Have decreased considerably | 25.6 | 23.7 | 16.6 |
| Don't know | 0.5 | 0.5 | 15.0 |

procurement. Principals claim that teacher salary funding has not been cut, but most teachers do not agree with this statement, arguing that they are paid less than before. In addition, teachers assess their financial standing lower than in the previous waves of the monitoring.

The higher teachers' qualifications (category) are, the more likely they are to report a decrease in salaries (Table 8), and vice versa: Category 2 teachers or those with no category at all are more likely to indicate that salaries have increased. It may be that schools pursue egalitarian teacher pay policies to provide incentive bonuses for young teachers with no category. At the same time, it is possible that the size of remuneration fails to meet the ambitions of the most highly qualified teachers. It is not improbable that both assumptions are true, explaining the differences in how teachers perceive the dynamics of

Figure 5. **Teacher beliefs about the level of teacher pay differentiation** (%)

There is a great differentiation between salaries of individual teachers, 25,0

There is no teacher pay differentiation, 13,1

There is a little differentiation between teacher salaries, 61,9

their salaries depending on the category. Anyway, the revealed trend reflects certain dysfunctions in the teacher pay system.

The worsening financial standing of teachers is due to, on the one hand, the negative economic trends in Russia resulting in a soaring cost of living and, on the other hand, a reduction in fee-based educational services. Due to a decrease in the effective parental demand, rural schools have virtually stopped offering such services, while most urban schools only manage to maintain fee-based preschool courses at the same level.

In most educational institutions, teachers are paid under an "effective contract" which includes a "base rate" and "supplemental payments". Every six months, each teacher submits a comprehensive portfolio, based on which a special committee decides on the size of supplemental payments for each individual teacher. School principals maintain that teachers with higher categories, greater work experience, more working hours and some kind of additional workload are able to earn much more than young teachers with no work experience, no qualifications and little workload.

Eighty-five percent of teacher respondents reported receiving additional incentive bonuses. The higher thr teacher category, the more likely incentive bonuses are to be granted. Coming back to explaining the difference in subjective teacher pay dynamics assessments, we can conclude that the most highly qualified teachers provided negative assessments not because they had no incentive bonuses at all but because the size of those bonuses did not meet their expectations. This is also proved by the data presented in Figure 5: there is some differentiation in salaries between more qualified and less qual-

Table 9. **The relationship between perceived financial standing and social self-identification of teachers** (% summed up row-wise)

| Perceived social status | Perceived financials standing | | | |
|---|---|---|---|---|
| | Above average | Average | Below average | Low |
| Above average | 4.9 | 63.1 | 23.5 | 8.6 |
| Average | 4.4 | 59.2 | 28.6 | 7.8 |
| Below average | 1.6 | 43.2 | 39.4 | 15.8 |
| Low | 0.5 | 21.3 | 36.1 | 42.1 |

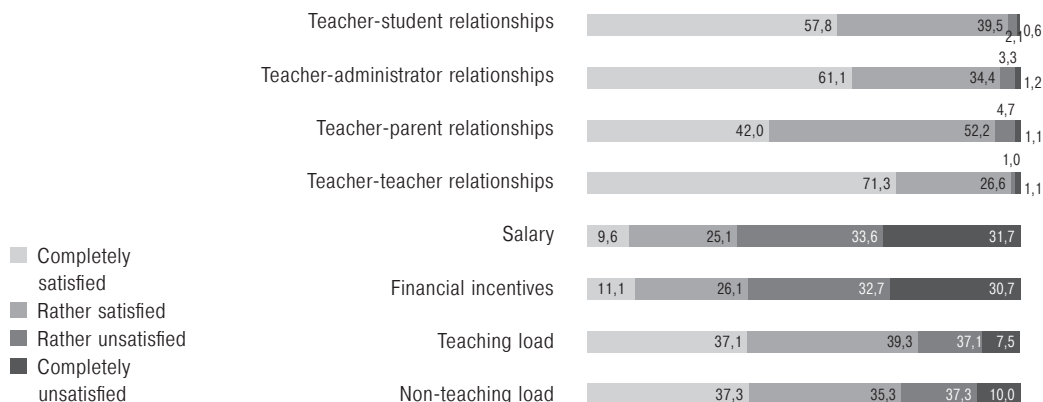ified teachers, but it is insignificant, as reported by most respondents (62%).

The first waves of the monitoring revealed egalitarian preferences of teachers concerning the distribution of incentive bonuses: most respondents favored uniform incentives for an equal number of working hours. However, the last wave shows a change in these attitudes: now, teachers want a greater differentiation in salaries to provide greater bonuses for teachers with better qualifications.

**Social positioning of teachers**

As an effect of the teacher pay increase, teachers were supposed to become a fully-fledged segment of the Russian middle class. Such social positioning was designed, firstly, to eliminate the problems that teachers faced when interacting with some parents, who were likely to see them as "service people" only, and, secondly, to take the teacher's mission to a higher level [Avraamova, Maleva 2014]. The last wave of the monitoring shows that social self-identification of teachers is rather heterogeneous: about 45% of respondents assess their social status as average or above average and 43% as below average or low. Obviously, there is no reason yet to rank all teachers among the middle class.

Meanwhile, half of the teachers assess their financial standing as average, with 46% identifying it as below average or low. Thus, we can see the asymmetry of status self-assessments, which demonstrates the so-called status inconsistency typical of non-meritocratic societies [Dadush, Shimelse 2012]. On the whole, teachers tend to assess their social status higher than their financial standing. The inconsistency between social position and remuneration causes low teacher job satisfaction to a large extent, which we dwell on below.

As we can see from Table 9, 23.5% of teachers assessing their social status as above average believe their financial standing is below average. However, status inconsistency does not apply to all of the teaching staff: about 40% of the teachers assessed both their social status and financial standing as average, and 10% assessed

Figure 6. **Teacher satisfaction with different job components** (%)



| | Completely satisfied |
|---|---|
| | Rather satisfied |
| | Rather unsatisfied |
| | Completely unsatisfied |

both categories of status as low. The most stressful situation arises when financial standing is assessed lower than the perceived social status.

Bringing the level of teacher salaries to the average regional indicators has not yet affected the prestige of the teaching profession. Most principals and teachers consider it to be low, referring to the following: (i) the public treating education as a service and teachers as service people; (ii) the mass media focusing on negative incidents from school life and ignoring positive news; and (iii) low teacher salaries.

**Job satisfaction**

Figure 6 shows that salaries are the most frustrating job component for teachers, both in terms of the base rate and incentive bonuses. Similar data was obtained in the previous wave of the monitoring, but the percentages of teachers completely unsatisfied with their salaries and incentives have increased by 8% and 10% in 2016, respectively. As a result, 65% of teachers are now rather or completely dissatisfied with their salaries, and 63% with the bonuses provided.

Workload, another component of the teaching profession, frustrates about 20% of teachers in the case of teaching hours and 27% in the case of non-teaching tasks.

The teacher job satisfaction index that we calculated[4] allows us to create a typology of teachers based on their job satisfaction (Fig. 7). Teachers whose job satisfaction can be defined as "above average"

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[4]   The index is calculated as a sum of points: any parameter that satisfies a teacher completely earns 3 points, and any "rather satisfying" one earns 1 point.
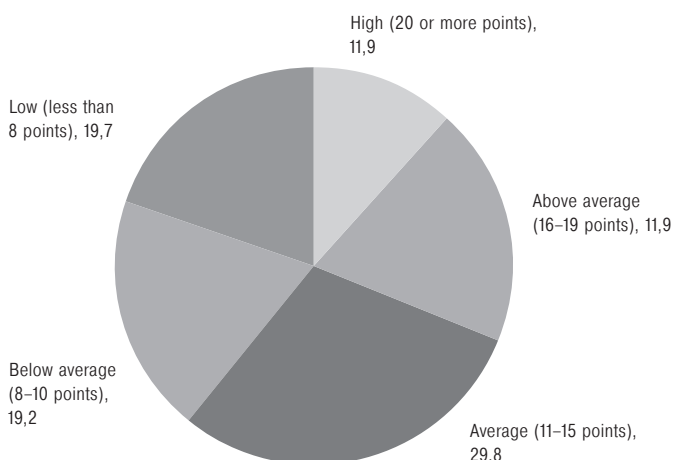
Figure 7. **Teacher job satisfaction index** (%)



Table 10. **Teachers' intentions to leave the school education industry depending on their job satisfaction levels** (% summed up row-wise)

| Job satisfaction (index value) | Intentions | | |
|---|---|---|---|
| | Yes | Maybe | No |
| Low | 11.5 | 29.0 | 59.5 |
| Below average | 7.1 | 25.8 | 67.1 |
| Average | 5.6 | 21.9 | 72.5 |
| Above average | 5.4 | 16.3 | 78.3 |
| High | 1.9 | 11.1 | 87.0 |
| Overall | 6.6 | 21.7 | 71.7 |

account for less than one-third of the total sample, while satisfaction "below average" is typical of 40%.

Dissatisfaction with specific job components, mostly salary, can encourage teachers to change their occupation. About 30% of the respondents leave this possibility open—they are mostly teachers whose overall job satisfaction is evaluated as low (Table 10).

**Territorial differences** The fourth wave of the monitoring demonstrates an alleviation of the territorial gaps in school education, which manifests itself in similar evaluations provided by principals and teachers of rural and urban schools. However, some substantial regional differences persist. In particular, these concern school staffing: whereas St. Petersburg

schools experience no problems with filling their vacancies, other regions surveyed suffer from staff scarcity.

A unique situation has developed in Altai Krai, where the quality of teaching is assessed higher than in other regions. However, the region demonstrates the worst teacher pay conditions: only 11% of the respondents report an increase in salaries (the sample average being 22%), and 46% actually report a considerable decrease (the sample average being 23%). In addition, 24% of the teachers in Altai Krai claim to receive no incentive bonuses (the sample average being 14%). Perhaps, this could be explained by the fact that Altai Krai has been affected the most by the economic downturn: 55% of the respondents said that the crisis was affecting them really badly (10% more than in Stavropol Krai and 20% more than in Chelyabinsk Oblast).

While teachers in Altai Krai report a sharp decrease in their salaries, most respondents in Chelyabinsk Oblast (41.5%) believe that the salaries have not changed (and so do 29.2% in the total sample). The situation in Stavropol Krai is closer to that in Chelyabinsk, except for being less stable: 31% of the respondents report no changes.

*To sum up the results* of the fourth wave of the school effectiveness monitoring, we can state that bringing teacher salaries to the level of average regional salary values has had positive effects on a range of indicators determining the effectiveness of school education. The chain of transformations launched by the remuneration reform has rejuvenated the staff composition of Russian schools, enhanced the quality of the teaching staff, contributed to better interaction between teachers and other school education actors, and outlined the framework of integrating Russian teachers into the middle class. The implementation of the Presidential Decree has opened the path in this direction, which will hopefully not be cut off due to the negative economic trends.

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# Employer Attractiveness of Universities:

## Measurement Approaches

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**Abstract.** The paper suggests principles and techniques for assessing universities, based on their employer attractiveness, which is measured by the demand for their products. Products of the University is 1) trained specialists (graduates), 2) research projects and technical-technological development 3) scientific results (articles in magazines)-each of these having their own consumers. It turns out that the level of employer attractiveness is determined by the organization of university resources: equipment and facilities, personnel, managerial structure and policies. The proposed university assessment principles provide the basis for a university ranking.

**Keywords:** university ranking, employer attractiveness, university product, assessment criteria, assessment indicators.

Among the basic characteristics of today's Russian higher education system (insufficient intellectual and material assets; low-efficient research and development activities; and low commitment to intellectual product commercialization [Kogan, Postalyuk 2008]), researchers emphasize the following most challenging drawbacks:

- Low commitment of universities to territorial development (as a rule, universities don't associate their own progress with economic and sociocultural development of the region and territories they supply graduates to);
- No experience of dealing with the labor market or involving businesses in the formation of staff resources, development of professional standards and student assessment criteria;

• Low association between admission mechanisms and prospects of regional labor market evolution;
• Extreme disintegration between science, education and businesses, which makes research development and personnel training divorced from economic realia and the needs of regional economies.

At the same time, universities are the key intellectual resource for regions but are insufficiently used by both executive authorities and local communities. The potential of higher education contravenes its limited participation in regional development: universities are unable to present their intellectual opportunities, while regional authorities and businesses are not ready to use them. Of course, such non-involvement of universities in the life of regions affects the educational process, which often evolves self-sufficiently, in complete isolation from real-life community problems.

The preferred focus of universities on meeting regional needs is a dominant trend in the development of higher education all over the world. In developed economies, universities shape the structure of regional labor markets to a large extent.

Factories and plants formed the kernel and pivot of cities and regions back in the industrial era. Today, their role has been passed on to universities and regional academic organizations as post-industrial "factories". Instead of being just educational or research institutions, they gradually evolve into fully-fledged participants of regional development, becoming the backbone of regional growth.

Researchers agree that higher education cannot be considered solely as a source of manpower at the level of state regional policy. This "extended" definition of university mission is explained by a number of factors. First, the academic and teaching staff of universities represent the brainpower of regional communities, which can become and is actually becoming a source of new ideas and projects, including those in legislation, consulting, and expert evaluation. Second, today's Russia mostly has regionally-oriented labor markets, so many researchers believe that internal, territory-related growth factors— human capital, historical traditions, and the cultural context of a given community—are crucial for regional economic development. Local labor markets are now assigned a much greater value than before, since the "right" educational structure of the population is one of the key long-term factors of economic growth [Belokrylova 2006; Zinkovsky 2007; Pilyasov 2007; Chelnokova, Firsova 2013].

The increased importance of higher education for regional development and industrial growth puts the need to develop adequate university performance assessment criteria on the agenda. Widespread assessment methods based on university resources inhibit effective positioning and use of higher education potential. Assessment of resources as a goal in itself should be replaced by assessment of performance and effectiveness of higher education, where resources

should be treated as a means of achieving the desired result. Organization of university assets, including human resources, normally mirrors university effectiveness.

The role of higher education in regional and industry-specific development depends on the quality of its products. The structure of its potential and social expectations determine three types of products: (i) new knowledge as a result of research and development activities; (ii) inventions in technology, engineering and humanities; participation in regional and industry-specific programs; (iii) the training of skilled personnel and keeping the skill levels of employed professionals up-to-date.

Each of the products has groups of potential consumers: the academic community, businesses and authorities at different levels, and undergraduate candidates. The extent to which a university engages to meet consumers' needs determines how demanded its products will be. Attractiveness may be taken as a basis of integral university characteristics. We suggest assessing universities based not on their organizational structure or resources but on the outside customer's demand for their products—basically, on their performance. This being understood, we assume that a good organizational structure provides an adequate quality of products, i.e. product quality measures the quality of the producing institution. Assessment logic like this brings us much closer to determining the actual role of a university in the regional economy and in industry-specific development.

The principles of university assessment proposed in this article will be used to provide a university ranking. From now on, we will only focus on university attractiveness, i.e. the demand for university products on the part of the market segments concerned.

## 1. How to measure university attractiveness

Higher education is designed to ensure production and capitalization of skilled labor and intellectual products (research and development, consulting, engineering support for companies and enterprises in different sectors), as well as to keep the skill levels of employed professionals up-to-date. Universities act as fully-fledged participants in education and intellectual property markets, competing for the customer whose demands determine university attractiveness.

Competitive factors can be of many different types: human capacity, material resources, and other operational conditions. We suggest analyzing only university performance, i.e. attractiveness of university products, as a competitive factor, assuming that operational conditions are always sufficient to provide the results observed. This is an integral criterion that indirectly considers the traditional factors of organizational structure and resources. Therefore, the proposed university assessment approach takes into account the following characteristics of university activities:

1) demand for university graduates (education products) in the real economy;
2) economic demand for design, development and consulting services rendered by the university;
3) the academic community's demand for the university's research products.

We assess these characteristics of university activities based on the following criteria:

- Attractiveness of university graduates in the labor market is measured by employer demand, i. e. how often graduates are employed upon a company's request, including the number of employer-sponsored education contracts.
- Attractiveness of a university's research and development products for real sector companies and enterprises is measured by the university's income from the sale of research and technology, projects and services designed to support companies and organizations' activities, as well as professional education programs.
- Academic attractiveness of research and development results asserted in scientific publications can be measured by the citation index.

To be able to use the assessment criteria, we need to introduce adequate and measurable indicators, which should meet the following requirements:

- be objective, i. e. based on external evaluations or information provided by a company whose officials are held responsible;
- be quantitative to ensure verifiability;
- be based on uniform statistical reporting procedures to ensure a valid data comparison.
- Such indicators may include:
- the percentage of graduates from full-time programs assigned to jobs;
- the proportion of income from R&D and educational services rendered to third-party organizations;
- citation indices of university authors' works.

University rankings are designed to achieve a specific objective and are for the attention of a specific consumer segment. By trying to bring various aspects of university activities together, ranking designers usually increase the number of indicators [Arzhanova et al. 2013; Zavarykina, Lopatina, Perfilyeva 2012]; as a result, indicators related to different assessment criteria eventually balance each other out in their final values. We presume that the number of indicators should be kept to a minimum, provided that they reflect the selected assess-

ment criteria—those of university product attractiveness—to the maximum possible extent.

Let us now dwell on the newly introduced criteria and indicators.

*Criterion 1*: Employers' demand for university graduates.

Employer's interest in university graduates is measured by businesses' requests. Most important here is not how many graduates get employed and by which means, but how actively they are demanded in the real economy. It is not employment as such that we assess, but targeted demand for professionals, which determines the "utility" of a university, i. e. the need for its products. University is regarded and perceived as a tool that can be used to enhance business productivity and contribute to territorial development.

Employers' demand is determined by the percentage of graduates assigned to jobs in the total number of university graduates from the main full-time programs.

The proposed indicator has two important characteristics. First, it independently measures and, more importantly, describes the demand for graduates through the majors offered by universities in response to businesses' requests. Second, it describes contractual relationships between the educational organization (students) and enterprises, institutions and organizations[1]. Job assignments are requested by organizations, which include employer-sponsored education contracts. It is assumed that graduates from additional, part-time, extramural and distance education programs are employed already.

Federal Statistical Monitoring ВПО-1, paragraph 2.9 "Job Assignments for Graduates from Full-Time Education Programs Funded from Budgets of All Levels" may serve as a source of information for quantitative indicator assessment.

*Criterion 2*: Commercialization of a university's end product.

The commercialization degree indicator is the proportion of income from commercialization of research and development products, professional training programs for organizations, and consulting services in a university's budget. The indicator considers two sources of university revenue: (i) income from research and development at the expense of all possible sources of financing; and (ii) funds received from organizations (not individuals) for educational services provided. This indicator is measured using Federal Statistical Monitoring ВПО-2, paragraph 3.1. "Distribution of Institution's Funds by Sources and Activities". This federal statistics provision allows for measuring objectively the demand for a university's research and technology products and its engagement in keeping the skill levels of employed professionals up-to-date. Basically, this group of products constitutes the ma-

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[1] Instructions for completing the federal statistical monitoring form (as amended by Rosstat Order No. 598 of October 2, 2014).

jor portion of a university's participation in the regional economy and territorial development.

The indicator is defined in the statistical monitoring form as "the specific weight of income from research and development and educational activity at the expense of extra-budgetary funds provided by organizations in the total amount of institution's funds actually received from budgets of all levels, extra-budgetary sources, and proprietary funds ".

*Criterion 3*: Academic attractiveness of a university's scientific product.

The role of scientific product is played by new knowledge as the result of scientific research. Demand for such product can be measured by the citation indices of university authors' works. Information is provided by the publication activity metrics of the Russian Science Citation Index (RSCI), chapter on "Comparing Bibliometric Indicators of Organizations": *i*-index of publication activity for each university, *h*-index, and the total number of citations of a university's publications in the RSCI.

The RSCI gives a quite comprehensive and objective picture of the publication activity of Russian authors and scientific institutions. The RSCI database contains information on both Russian-language publications and Russian publications in foreign languages as well as journals that have English versions. In assessing publication activity and the citation impact of Russian researchers and scientific institutions, the RSCI uses information on publications of Russian authors and works that cite them contained in the Scopus international citation database, making it possible to consider not only publications in RSCI-indexed Russian periodicals but also publications of Russian authors in foreign journals[2].

The advantage of the proposed approach to university performance assessment is that it does not require making direct requests to concerned institutions, thus helping to avoid subjectivity.

Having assessed the demand for university products, we can make a ranking of universities based on their attractiveness in specific industries. Such a ranking will allow prospective consumers of higher education services to understand their chances of getting an education that will make them competitive in the regional or national labor market, the expected effectiveness of attracting the university to solving development problems of companies, economic sectors and territories, and the feasibility of their hopes for new scientific research results and the training of academic researchers.

A ranking like this will provide structured information to those choosing a university in order to solve their own problems; it is designed for those who regard universities as a resource of their own success.

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[2] http://elibrary.ru/projects/citation/cit_index.asp

Therefore, the ranking objectives are determined to meet the requirements of the key segments of consumers of products and services provided by universities, i. e. they ought to:

- provide concerned individuals and companies with information on university opportunities for training professionals capable of working in a real competitive economy;
- inform businesses of a university's potential to solve their technology, organizational and personnel problems;
- inform the academic community and other concerned parties of a university's research productivity.

**2. Popular university rankings**

Rankings of higher education institutions are constantly created in Russia and on an international scale. The range of ranking criteria is very wide[3], since consumers interested in educational services are motivated by the most diverse factors when assessing or selecting a university. Different criteria classification and prioritization methods provide a diversity of rankings to meet the interests of different target groups.

Within the scope of assessment, rankings vary from generalized (the top universities in Russia) to consumer-customized (a ranking of Moscow universities by tuition fees).

The most well-known producers of Russian rankings include: ReiTOR Independent Rating Agency, the Ministry of Education and Science of the Russian Federation, the Russian Rectors' Union, Business Russia Public Organization, Vladimir Potanin Foundation, Russia Today International News Agency (MIA Russia Today), Interfax, Echo of Moscow radio station, the Kommersant publishing house, *Career* magazine, *Finance* business magazine, SuperJob Internet recruiter, and others.

The Social Navigator project of MIA Russia Today (formerly RIA Novosti)[4] in cooperation with the National Research University Higher School of Economics (NRU HSE) monitors around 500 higher education institutions based on the average USE (Unified State Exam) admission score. This monitoring is used to create university rankings with sub-rankings for different disciplines or university categories. The Social Navigator rankings take into account universities' reputations inherited from Soviet times, which is at odds with other local and global rankings, such as the Academic Ranking of World Universities[5], the

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[3] The general idea of Russian and global ranking criteria is given in [Ivanova 2015].

[4] RIA Novosti's Admission Quality Ranking of Russia's State Universities. http://ria.ru/ratings_academy/

[5] Conducted by the Center for World-Class Universities (CWCU) of Shanghai Jiao Tong University. http://www.shanghairanking.com/ru

Times Higher Education World University Rankings[6], or the QS World University Rankings[7].

*Forbes Life* magazine offers a ranking of universities that produced the highest number of the top 200 Russian Forbes billionaires[8]. The ranking is based on the cumulative wealth of billionaire alumni.

In 2011–2013, the National Personnel Training Foundation (NPTF)[9] assisted by experts from the Center for International Comparative Research (Institute of International Organizations and International Cooperation, NRU HSE) implemented a project called Development and Testing of Professional Education Institution Ranking Methodology. This multidimensional ranking methodology allows the comparison of universities based on either cumulative data (aggregates) or individual parameters and activities.

The Ministry of Education and Science of the Russian Federation has monitored the effectiveness of Russian education institutions since 2013[10]. This Monitoring explores a series of indicators grouped into eight areas: education, research and development, international outlook, financial and economic activity, faculty salaries, employment policy, students enrolled, and additional educational institution indicators. The Monitoring is designed to provide information support for managerial decisions and has brought the notion of "ineffective university ranking" into use.

All the above mentioned rankings have the following characteristics, which are both advantages and limitations:

- The multidimensionality and comprehensiveness of the indicators is achieved by considering different aspects of university activities.
- The lack of statistical information available is compensated for by direct requests to universities subject to ranking.
- Weight coefficients of the indicators (and their distribution across the groups of ranking factors) are normally assigned based on expert opinions, whereas the methodology requires a substantial justification of weight assignment (within the model tested).
- In the absence of necessary quantitative data, interrogatory methods are used to collect information from applicants, students and graduates.
- Nearly all of the rankings include indicators of university authors'

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[6] One of the oldest and most prestigious rankings. https://www.timeshigher-education.com/world-university-rankings/2015/world-ranking#!/page/0/length/25

[7] A ranking by British company Quacquarelli Symonds (QS) assessing universities in 20 emerging economies of Europe and Central Asia.

[8] http://www.forbes.ru/forbeslife/obrazovanie-i-karera

[9] http://ranking.ntf.ru/

[10] http://indicators.miccedu.ru/monitoring/

publication activity. Meanwhile, using these indicators to compare different types of higher education institutions is not entirely flawless: as we know, citation indices (*h*-index and other publication activity indicators) depend largely on the field of research[11].

**3. Using university product attractiveness indicators to create rankings**

The selected university assessment indicators are used in a number of Russian and global rankings, in different combinations with other indicators. However, none of the famous rankings includes a set of indicators as a characteristic of outside consumer's demand for university products. The indicators used in rankings are more likely to describe university processes or resources than performance. Even when some indicators consider university effectiveness parameters, they are not regarded from the attractiveness perspective and do not measure the outside demand for this effectiveness. When these indicators are used in combination with process-related ones, their contribution to university assessment is leveled off in the final ranking.

**3.1. Citation index**

Most Russian and global rankings use bibliometric indicators of university authors' publication activity. They use *research productivity* indicators, e. g. the number of articles published in reputable peer-reviewed journals (The Academic Ranking of World Universities) or the number of papers per faculty member (the THE World University Rankings), as well as *citation* indicators, e. g. the average number of citations per article (the THE World University Rankings) or citation indices per faculty member (the THE World University Rankings), most often *combining* both types.

For instance, the annual Monitoring of Universities conducted by the Ministry of Education and Science of the Russian Federation uses the following bibliometric indicators: the number of citations received by articles published in the previous five years and indexed in Web of Science per 100 faculty members; the number of citations received by articles published in the previous five years and indexed in Scopus per 100 faculty members; the number of citations received by articles published in the previous five years and indexed in the RSCI per 100 faculty members; the number of university publications indexed in Web of Science per 100 faculty members; the number of university publications indexed in Scopus per 100 faculty members; the number of university publications indexed in the RSCI per 100 faculty members; and the overall number of university publications per 100 faculty members (among 62 other university performance indicators).

Popular citation indices, like *h*-index, have a number of disadvantages as research productivity indicators, being, for example, depend-

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[11] https://ru.wikipedia.org/wiki/H-%D0%B8%D0%BD%D0%B4%D0%B5%D0%BA%D1%81

ent on the field of research. Meanwhile, *i*-index is less associated with the field of research, assessing the demand for the university's (not an author's) publications in most diverse areas available. In fact, this indicator measures the number of acknowledged (highly cited) researchers in a given university.

### 3.2. Income from R&D and educational services rendered to third-party organizations

University ranking indicators also assess the research performance of universities quite often, which is usually externalized in the "proportion of income from R&D in the overall income of the educational institution". However, this reasonably clear indicator accretes a number of additional ones: the proportion of R&D completed using a university's own resources (with no co-contractors involved) in the university's overall income from R&D; the income from R&D (except that from budgetary funds of the Russian Federation and national science foundations) per faculty member; the number of license agreements; the proportion of funds obtained by educational institutions from using their intellectual products in a university's overall income (based on the Monitoring conducted by the Ministry of Education and Science of the Russian Federation). Each of these indicators carries a certain weight in determining the final ranking. It is no surprise that income from a university's intellectual products as such is thus compensated by and dissolved in a number of related indicators.

R&D performance indicators in popular university rankings are interpreted as "scientific achievements" but not as the demand for (return on) intellectual products. At the same time, another aspect of intellectual product attractiveness—employee retraining services for real economy enterprises—is considered in the Education Activity or Extra-Budgetary Educational Services sector, along with fee-based educational services provided to the population.

### 3.3. Assigning graduates to jobs

In the abovementioned rankings, assigning graduates to jobs is understood as engaging them in labor relations and making them part of the economy. The abundant indicators of employers' demand for university graduates feature no such familiar Federal Statistical Monitoring factor as "assigning graduates to jobs upon employers' requests". In particular, the only indicator used in the Ministry's Monitoring is "the proportion of graduates employed within one calendar year after graduation in the overall number of university graduates from the main full-time programs", calculated based on the Pension Fund data (i. e. it does not consider whether a graduate is employed in their field of study or not).

Therefore, job assignments for graduates cannot be regarded as a pronounced employer demand for university professionals.

### 4. Objects of ranking

Qualities assessed using the ranking criteria have different origins in different fields because the specific features of a university's product

determine its market and capitalization conditions. So, to be able to correctly compare the university performance indicators from different categories, we need to group universities based on similar or related types of activities.

We suggest dividing universities into six categories:

- Classical universities;
- Engineering (technical) universities;
- Agricultural universities;
- Management universities (economics, finance, law);
- Universities in humanities (pedagogy, philology);
- Medical universities.

With a classification like this, we minimize the number of field overlaps between the categories. The proposed breakdown of universities into categories based on their major fields of study is consistent with classifying publications based on areas of research in the RSCI database: engineering, natural sciences, medicine, agriculture, social (including pedagogical) sciences, and humanities. A similar classification was used to develop and test a multidimensional ranking model under the NPTF project[12].

At the same time, the proposed system of assessment criteria is essentially invariant for different types of universities: attractiveness serves as a strategic goal achieved via markets of relevant products. This observation may be used to rank universities regardless of the above classification or to introduce another classification based on other significant parameters.

The sample does not include branches (local subdivisions) of higher education institutions, military colleges, extramural and distance education institutions, theological (divinity) schools, and universities of art and culture—the criteria for assessment of their performance differ from those proposed in this article.

We also omit institutions with no necessary information available in the Federal Statistical Monitoring ВПО-1 or ВПО-2, as well as those not indexed in the RSCI.

**5. University rankings based on the selected assessment criteria**

We present the results of using the described indicators to create university rankings based on the data obtained by MIA Russia Today with our participation in 2015. All in all, we ranked 463 universities from 80 subjects of the Russian Federation (Table 1).

The distribution of universities based on the indicator "the proportion of graduates assigned to jobs in the overall number of graduates from the main full-time programs" indicates a pretty high demand for

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[12] http://ranking.ntf.ru/DswMedia/larionovamarinaplenary1_24042013.pdf

Table 1. **The distribution of universities based on their main fields of study**

| | |
|---|---|
| Classical universities | 87 |
| Engineering (technical) universities | 140 |
| Agricultural universities | 56 |
| Management universities (economics, finance, law) | 61 |
| Universities in humanities (pedagogy, philology, physical education and sports) | 72 |
| Medical universities | 47 |

Table 2. **The proportion of graduates assigned to jobs across different university categories**

| Type of university | Average (%) | Min. (%) | Max. (%) | No. of observations |
|---|---|---|---|---|
| Classical universities | 55.8 | 0 | 100 | 87 |
| Engineering (technical) universities | 67.4 | 0 | 100 | 140 |
| Agricultural universities | 75.6 | 3 | 100 | 56 |
| Management universities (economics, finance, law) | 30.0 | 0 | 100 | 61 |
| Universities in humanities (pedagogy, philology, physical education and sports) | 56.4 | 0 | 100 | 72 |
| Medical universities | 41.1 | 0 | 100 | 47 |
| All universities ranked | 56.9 | 0 | 100 | 463 |

university graduates in the labor market (Table 2). The proportion of graduates assigned to jobs is the highest in agricultural universities, reaching on average three quarters (75.6%) of all graduates. Graduates from management universities appear to be the least demanded by employers (about 30% on average).

The number of job assignments provided to university graduates reflects the market demand for graduates of specific higher education institutions.

Table 3 shows the distribution of universities based on the indicator "the proportion of income from commercialization of R&D products and professional training programs for organizations in a university's budget". Not unexpectedly, engineering universities demonstrate the highest proportion of income from intellectual product commercialization, which is about 16% of their budgets. Lower values are observed in medicine and humanities-8.3% and 8.4%, respectively. Agricultural universities show the lowest proportion of all.

Only a small proportion of universities (from 3% to 15% in different categories) receive no income from selling R&D products or render-

Table 3. **The proportion of income from commercialization of R&D products and professional training programs for organizations in a university's budget**

| Type of university | Average (%) | Min. (%) | Max. (%) | No. of observations |
|---|---|---|---|---|
| Classical universities | 10.8 | 0 | 79 | 87 |
| Engineering (technical) universities | 16.0 | 0 | 52 | 140 |
| Agricultural universities | 6.6 | 1 | 15 | 56 |
| Management universities (economics, finance, law) | 11.1 | 0 | 82 | 61 |
| Universities in humanities (pedagogy, philology, physical education and sports) | 8.4 | 0 | 57 | 72 |
| Medical universities | 8.3 | 0 | 22 | 47 |
| All universities ranked | 11.3 | 0 | 82 | 463 |

Table 4. **Mean *i*-indices of citation of university authors' publications across university categories**

| Type of university | Mean *i*-index | Median | Min. (%) | Max. (%) | No. of observations |
|---|---|---|---|---|---|
| Classical universities | 11.11 | 10 | 4 | 40 | 87 |
| Engineering (technical) universities | 9.85 | 9 | 4 | 29 | 140 |
| Agricultural universities | 7.57 | 7 | 4 | 17 | 56 |
| Management universities (economics, finance, law) | 8.69 | 8 | 3 | 24 | 61 |
| Universities in humanities (pedagogy, philology, physical education and sports) | 7.35 | 7 | 2 | 17 | 72 |
| Medical universities | 10.49 | 10 | 5 | 23 | 47 |
| All universities ranked | 9.33 | 9 | 2 | 40 | 463 |

ing educational services to organizations. Over half of the universities in each category receive a relatively low income from these activities (5–10% in the overall university budget). About 15–20% of agricultural and medical universities deal with this type of revenue once in a blue moon. Proportions of over 25% in the overall university budget are mostly demonstrated by engineering universities.

Attractiveness of university products based on "the citation index of university authors' works" is assessed using the organization's *i*-index. Highly cited researchers are a gauge of university research performance. The mean *i*-index values across university categories are presented in Table 4.

Naturally, the citation index is not a perfect instrument. Citation indices (*i*-index and *h*-index) have specific patterns in different areas of research—an issue that has been constantly reported by researchers[13].

However, citation indices of the universities subject to ranking do not differ too much depending on the university category. In our opinion, the lack of significant differences in the discussed indicator between the university categories in our sample (unlike the differences based on the fields of study) is explained by the diversity of research and development areas in university activities (the process of "universitization").

The distribution of universities based on citation indices offers quite a comprehensive picture of the characteristics of the demand for scientific publications across the predetermined university categories. Most universities in agriculture and humanities show the maximum *i*-index values of 6–7 highly cited researchers, as compared to 8–11 in medical universities and a broader range of 6–7 to 10–11 and even 12–13 in engineering and management universities. The highest values of 8–9 to 12–13 highly cited researchers are demonstrated by classical universities.

To construct the final ranking, calculated as the sum of all indicators used, we normalize the obtained indicator values to ensure data comparability.

When creating complex rankings, it is essential to use weight coefficients indicating the priority of specific indicators. When intermediate (particular) values of ranking indicators are summed up, the weights of these indicators are considered equal. In other words, the cumulative consumer's demand for a university's products is assessed indiscriminately for all the three indicators introduced.

The complete ranking of Russian universities based on the demand for their products is available on the website of the Social Navigator project[14].

Classical, engineering and agricultural universities show the closest distribution of their final indicators. However, positive extreme values reveal some universities that stand out. Universities in management, humanities and medicine are less homogeneous in their final rankings, but they also feature some exceptionally successful institutions, whose high attractiveness manifests itself in the consolidated indicator.

The proposed criteria describing the demand for relevant university activities and products have different weight coefficients in different universities. This is a result of differences in university policies shaped

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[13] Например: http://eqworld.ipmnet.ru/ru/info/sci-edu/Polyanin_IndexH_2014.html

[14] http://ria.ru/abitura_rus/20151215/1341953336.html

by outside requests and the extent to which they are realized. "Globalization will continue to gather pace, but what we've seen recently, as in other markets, is the growing impact of technology, which threatens many components of the traditional university" [Barber, Donnelly, Rizvi 2013:187] as well as the areas of demand for universities.

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# The Structure of Students' Motivation:
## Expectancies and Values in Taking Data Science Course

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**Abstract.** In this paper we explore motivational structure of students taking a challenging university course. The participants were second-year undergraduate students majoring in Economics, Sociology, Management and Humanities, enrolled in the Data Science minor. Using expectancy-value theory as a framework, we aim (1) to analyze gender differences in motivation; (2) to identify the link between the components of motivation and academic achievement; (3) to estimate the role of the previous academic achievement and educational choices. Two alternative theoretical models are proposed and tested on empirical data. Structural equation modeling (SEM) in MPlus 7.31 was used for analysis. We found that the course is more popular among males students, who also demonstrate higher level of expectancy for success. However, there is no gender difference in academic performance. Students majoring in Sociology and Economics perceive Data Science as more interesting and useful than Management and Humanities students. SEM analysis empirically validated the model in which expectancy of success directly influences academic achievement, and values influence is mediated by expectancies. The final model that includes motivation, gender, student's major, and previous achievement explains 34% of variance in academic performance. We discuss the role of different components of student motivation and practical significance of our results.

**Keywords:** motivation, expectancy value theory, gender differences, statistics, data science.

One of the most important practical issues in educational research is how to enhance the academic performance of students. Numerous

explanations of low performance typically come down to two major reasons: lack of capabilities and low motivation for learning. Unlike capabilities, which are almost impossible to correct, motivation can be changed—and this generates the ongoing interest of researchers in this field [Hidi, Harackiewicz 2000]. Several theories associating different components of motivation with educational choice and academic performance have been developed over the last 30 years [Bandura 1993; Eccles, Wigfield 1995; Pintrich 2003; Ryan, Deci 2000; Wentzel, Wigfield 2009; Wigfield, Eccles 2000].

This paper analyzes the relationship between motivation and performance using the example of Data Science minor, or optional course, offered to students majoring in different areas, from Economics to Oriental Studies. Minors are obligatory for all students of the St. Petersburg campus of the National Research University Higher School of Economics. A student can pick any of the five minors, regardless of their major. A minor consists of four semester-long courses, each worth five ECTS credits.

We study the motivation of students who chose Data Science as their minor, which includes learning the fundamentals of programming with R for machine learning and related topics, as well as developing data analysis skills. The course developers created the Data Analysis computer system to conduct online surveys, collecting data on students' attitudes and learning behavior (number of code lines written, forum activity, seeking help from peers and teaching assistants), and correlate this information with academic achievements [Musabirov, Sirotkin 2016]. Therefore, research on student course-related behavior becomes integrated in modern learning analytics and educational data mining [Baker, Inventado 2014; Siemens, Baker 2012].

## 1. Literature Review
## 1.1. Motivation as a Predictor of Academic Performance

A number of theoretical and applied studies have explored the factors of good academic performance. There is no doubt that cognitive abilities matter, but other student characteristics are significant, too. In higher education, particularly in selective universities, the selection process greatly diminishes the variation of intellectual skills of students [Furnham, Chamorro-Premuzic, McDougall 2002], increasing the role of such personal qualities as character traits, individual learning strategies and motivation as the reasons behind different levels of academic performance [Richardson, Abraham, Bond 2012].

Motivation is understood as a combination of mental processes initiating a specific behavior. Psychologists have developed a great deal of motivation theories, in terms of learning as well [Pintrich 2003]. The modern motivation theories focus on how exactly human behavior is influenced by beliefs, values and goals.

In this paper, we rely on John W. Atkinson's expectancy-value theory [Atkinson 1964], which was expanded by Jacquelynne S. Eccles and Allan Wigfield into the field of education [Eccles, Wigfield 2002;

Wigfield, Eccles 2000]. The theory suggests that motivation involves two factors: expectancies and subjective task values. Expectancies are specific beliefs individuals have regarding their success on certain tasks or activities; task values are incentives, or reasons that stimulate people to do something.

The proponents of the theory believe that both expectancies for success and subjective task values directly influence the choice of activity, the persistence in it, and the final result. Besides, the two factors influence each other. These cognitive characteristics may be affected by previous experience (especially in a similar task), gender and other stereotypes, beliefs about one's abilities, etc. In its full form, the expectancy-value theory is described by a complex equation [Eccles, Wigfield 2002:119], all the components of which cannot be possibly covered in one study. Researchers usually focus on proximal to educational outcomes components, i.e. expectancy for success and subjective task value. While developing their theory, Eccles and Wigfield identified four subcategories of task values: intrinsic value (interest), attainment value (importance), utility value (usefulness of the task), and cost.

Intrinsic value reflects the interest in the subject, or the enjoyment an individual gets from performing the activity. Attainment value reflects personal importance of doing well on the task. Utility value means relevance of the task to current or future goals, e.g. a boring and difficult course may be perceived as useful for a future career. Costs reflect negative aspects of engaging in the task: a person believes that participation in a task may limit his/her achievements or impede his/her activity in other fields; it can be time costs, effort costs, or emotional costs.

Most of the empirical studies based on the expectancy-value theory have involved school students. . One important result was that such theoretically different constructs as belief in one's capabilities and expectancy for success turned out to be empirically undistinguishable: in confirmatory factor analysis relevant items always loaded on the same factor. Second, expectancy for success is a domain-specific construct, i.e. a student may be confident about his or her success in humanities, but it does not mean they feel confident in math. Third, school students are good at discriminating between expectancies and values, i.e. between rating their chances of success and estimating how this success is important for them [Eccles, Wigfield 1995; Wigfield, Eccles 2000].

Another essential finding, the most important for our research, is that motivation is a powerful predictor of academic performance (previous experience being controlled for); and expectancies play greater role in performance than values [Meece, Wigfield, Eccles 1990].

Most relevant for our work are studies that have applied Eccles and Wigfield's theory to students learning mathematics, programming and sciences [Abraham, Barker 2015; Hood, Creed, Neumann 2012].

Both teams of researchers demonstrated clearly that the expectancy-value model provided a very good description of empirical data, and that motivation components had a strong positive correlation with efforts applied by students, with their choice of complex courses, and their academic achievements.

The level of motivation, in turn, also depends on a number of factors. Beside gender and cultural stereotypes, previous experience is of great importance, too. Quite naturally, a student who has performed well in math courses so far expects to be successful in a new one [Meece, Wigfield, Eccles 1990; Simpkins et al. 2006]. Therefore, it is very important that a motivation model include variables indicating previous achievements.

## 1.2. Gender Differences in Motivation and Achievement Patterns in Mathematics

The role of gender stereotypes in achievement motivation has been a topic of research for a long time. Despite different theoretical foundations of research, most researchers agree that gender stereotypes largely affect girls' and boys' beliefs about their capabilities and, as a result, their learning behavior (e. g. courses preferred or the choice of an educational trajectory and later career) [Meece et al. 2006]. Boys are believed to be better at and more inclined towards science and mathematics, while girls are thought to excel at languages and humanities. Gender differences in beliefs about one's capabilities are especially pronounced in primary school and can be leveled out to some extent during the learning process [Jacobs et al. 2004].

Although girls' beliefs about their mathematical capabilities and their expectancies for success in math are always lower than those of boys, the findings based on grades and test scores are less unambiguous. Some researchers reveal that boys score higher, while others find no differences at all [Hedges, Nowell 1995; Lindberge et al. 2010]. The data obtained in international studies (TIMSS, PISA) allow for evaluating gender differences in mathematics across countries and correlating them to such country characteristics as the percentage of women in high-tech fields of science, representation of women in parliament, etc. Paradoxically, the broadest gaps between boys and girls in PISA were revealed in Switzerland, the Netherlands and Germany, whereas PISA scores of Russian school students show no gender-based variations [Else-Quest, Hyde, Linn 2010]. Russian researchers who studied USE (Unified State Exam) scores in mathematics with a very large sample— all graduates from Russian schools who took the USE in 2011 (over 700,000 students)— did not find any differences between girls and boys either [Bessudnov, Makarov 2015].

## 1.3. Perception of Statistics as a Factor of Academic Performance

It stands to reason that attitude towards a subject affects performance in that subject. Difficult courses like math or statistics often arouse anxiety in students, holding them back [Meece, Wigfield, Eccles 1990; Peng, Hong, Mason 2014; Simzar et al. 2015]. Attempts to solve this problem include the development of the Math Anxiety Scale and the

Statistics Anxiety Scale [Hopko et al. 2003; Schau et al. 1995] as well as research into cognitive and non-cognitive (emotional in particular) factors of teaching statistics effectively [Emmioğlu, Capa-Aydin 2012; Hood, Creed, Neumann 2012]. Meanwhile, there are relatively few studies addressing differences in attitude towards difficult courses among students of different majors. Griffith and his colleagues have established that attitudes of students in different fields of study differed significantly across three parameters: expected utility (for both further education and future career); perception of the course as intellectually challenging; and passion for mathematics. Attitude towards statistics was found to be overall positive among business students, less positive among psychology students, and overall negative among students in forensic science [Griffith et al. 2012].

## 2. Research Goals, Objectives and Models

The goal of this paper is to explore the motivation of students of different majors in taking the STEM course. We focused our efforts on the following three objectives:

- Find out whether there are gender differences in motivation for the course;

- Identify the structure of the relationship between the motivation components and academic performance;
- Assess the significance of previous academic achievements and educational choices (opting for a specific major).

In empirical testing the expectancy-value theory on various groups of students in different educational contexts, researchers have discovered interrelations between the motivation components and academic performance which were different in their nature. Drawing on the previous research, we constructed two theoretical models describing those interrelations: 1) expectancies and values influence academic performance directly and independently; 2) values influence expectancies (but not academic performance), and expectancies, in their turn, influence academic performance (Fig. 1).

Both models include gender, previous academic achievements, and current major.

## 3. Data and Methods
### 3.1. Empirical Basis of Research

Data for the research was gathered through a survey of students who chose Data Science as their minor. A distinctive feature of the Higher School of Economics campus in St. Petersburg is the absence of mathematical and computer science majors, so the minor's target audience consisted of students in economic, management, humanities and social science majors, from Economics to History. The diversity of majors and the differences in training background, primarily in terms of school and university mathematics, determined both the differenc-

Figure 1. **Two alternative models of interrelations between the motivation components and academic performance**

**Model 1**



SUBJECTIVE TASK VALUES

**Model 2**



SUBJECTIVE TASK VALUES
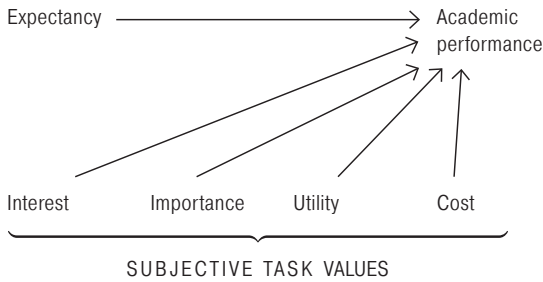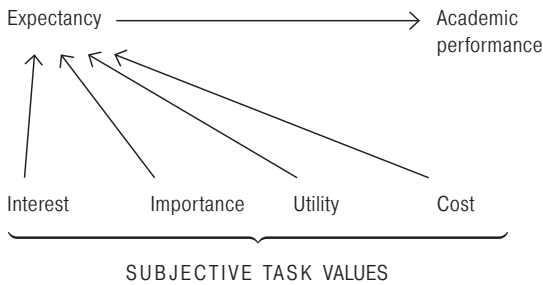
es in motivation for choosing this minor and, presumably, the development of contrasting types of behavior and interaction.

Data Science was most often chosen by students studying Economics and Sociology and most rarely by those in History, Politology and Jurisprudence (Table 1). It was the most popular minor among sociologists, selected by 42% of second-year students in Sociology. The possible reason behind this is that the minor was first introduced as an optional course in the Sociology Department, so it was more familiar to sociologists than to students of other majors.

The survey was conducted at the beginning of the minor's first year (second year of Bachelor's degree) and involved 149 students, which is 94% of all students enrolled in the minor.

**3.2. Indicators** A survey questionnaire was developed. The full achievement motivation equation based on the expectancy-value theory includes over 20 components, so empirical studies only use some of the theoretical constructs according to a specific objective. We selected five: expec-

Table 1. **Distribution of Data Science students across majors**

| Major | Number and percentage of students in the minor | Number of respondents and their proportion in the sample |
|---|---|---|
| Economics | 46 (29%) | 41 (28%) |
| Sociology | 36 (23%), | 35 (23%) |
| Management | 16 (10%) | 15 (10%) |
| Logistics | 25 (16%) | 24 (16%) |
| Oriental Studies | 14 (9%) | 13 (9%) |
| History | 6 (4%) | 5 (3%) |
| Politology | 7 (4%) | 7 (5%) |
| Jurisprudence | 5 (3%) | 5 (3%) |
| Public administration | 4 (2%) | 4 (3%) |
| Total | 159 | 149 (94%) |

Table 2. **Scale reliability coefficients**

| Construct | No. of items | Cronbach's α |
|---|---|---|
| Expectancy for success | 4 | 0.83 |
| Interest | 6 | 0.86 |
| Importance | 4 | 0.85 |
| Utility | 5 | 0.79 |
| Cost | 4 | 0.67 |

tancy, interest, utility, importance, and cost. A Russian version of the scale was prepared for each of the constructs based on Eccles and Wigfield's questionnaire for exploring the motivation components in mathematical courses[1] [Eccles, Wigfield 1995]. The scales for individual constructs consisted of 4–6 items with responses on a four-point Likert scale, from 1 (Strongly disagree) to 4 (Strongly agree). Internal consistency of the scales was rather high (Table 2).

The dependent variable in our model was academic performance in Data Science measured as a cumulative score for two tests, in the middle and at the end of the first semester. All of the models consid-

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[1] To validate our instrument, we analyzed the factor structure of the questionnaire using confirmatory factor analysis. The resulting model showed a high degree of fit with empirical data. A detailed description of this work is beyond the scope of this paper and is a topic for a separate publication.

ered student's gender, previous academic achievements (GPA for the first year), and current major as important determinants.

*Academic performance* (dependent variable) was operationalized as the cumulative score for the first semester in the minor and measured as the arithmetic mean of student's scores for two final tests, one at the end of Module 1 and the other at the end of Module 2[2].

*Expectancy for success* was measured using a four-item scale. Example of an item: "I expect to do well in this course." The level of expectancy was calculated as the arithmetic mean of responses to four items.

*Interest* was assessed using a six-item scale. Example of an item: "I find the Data Science minor interesting." The degree of interest was calculated as the arithmetic mean of responses to six items.

*Importance* was measured using a four-item scale. Example of an item: "For me, being good at this course is very important." The importance of being good was calculated as the arithmetic mean of responses to four items.

*Utility* was assessed using a five-item scale. Example of an item: "What I learn in Data Science will not be useful for me at all when I graduate." Perceived utility was calculated as the arithmetic mean of responses to five items.

Expected *cost* of time and efforts was measured using a four-item scale. Example of an item: "I fear that the minor program will interfere with my other courses." Cronbach's α for this scale was 0.67, which is less than for other scales in this research, yet this degree of reliability is considered a good one. Perceived cost was calculated as the arithmetic mean of responses to four items.

*Gender* was coded as a binary variable (0 = female and 1 = male). The sample included 102 females (64%) and 57 male students (36%).

*GPA* for the first year of studies was used as an indicator of previous academic performance. It would be incorrect to compare GPAs of all Data Science participants directly, as they were enrolled in courses of different complexity and assessed by instructors with different levels of requirements within their majors. To make a comparison like that possible, we standardized the variables based on students' majors, i. e. for each student, we calculated the difference between their personal GPA and the mean GPA of all students in their major.

The current *major* was coded as a nominal variable. Some majors were represented by too few students, so it made no sense analyzing them individually. We merged students in History, Politology, Oriental Studies and Jurisprudence into "Humanities". Unlike Economics, Sociology, or Management, the abovementioned majors offered few mathematical and statistical courses; this could be the reason for

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[2] The Higher School of Economics applies a module-based learning system: the first semester consists of Modules 1 and 2, and the second one of Modules 3 and 4. Tests are taken at the end of each module.

students in these majors not opting for Data Science too often. We also merged Management and Logistics students because their majors were very closely related. As a result, the students in our sample were distributed as follows: 47 in Economics, 36 in Sociology, 40 in Management and Logistics, and 36 in Humanities.

**3.3. Analysis Methods**

We used structural equation modeling (SEM) realized in the MPlus version 7.31 statistical package as the basic analysis method [Muthén, Muthén 1998]. This method allows for testing associations between variables, including latent factors. The structural model represented a system of regression equations describing correlations between the dependent and independent variables.

Structural equation modeling is used to construct theoretical models and test their goodness of fit, i. e. how well they fit data observed in research. We used three measures of goodness of fit recommended by the majority of modern SEM guidebooks: CFI (Comparative Fit Index), acceptable CFI values $\geqslant 0.90$; RMSEA (Root Mean Square Error of Approximation), acceptable RMSEA values $\leqslant 0.05$; and SRMR (Standardized Root Mean Square Residual), acceptable SRMR values $\leqslant 0.08$. These are indicators of differences between the original covariance matrix and the matrix of covariances of the model, which allow the researcher to measure the goodness of fit of a model to a set of observations [Nasledov 2012: 348–353]. A comparison of fit indices makes it possible to choose the best alternative models.

To compare characteristics of different groups of respondents, we used the *t*-test (or ANOVA) for normally distributed variables, and the Mann–Whitney *U* test (or the Kruskal–Wallis test) and the Dunn's test of multiple comparisons for non-normally distributed variables.

**4. Findings**
**4.1. Analysis of Gender- and Major-Related Differences**

18% of all females and 26% of all males selected the Data Science minor, which means that the minor was more popular among male students. With a view to finding out whether there were gender differences in motivation and academic achievements, we compared the values of five motivation components (expectancy for success and four subjective task value parameters) and two different measures of academic performance (GPA for the first year and Data Science test scores) (Table 3).

Although girls perform better at university (as the GPA comparison shows), they are less confident about their abilities when it comes to a difficult course involving programming. However, despite the difference in expectancies, males and females show similar levels of academic performance (Data Science test score). Such motivation components as interest, utility, importance and perceived costs also appear to be the same for both genders.

Since students of different majors who chose Data Science as their minor had different backgrounds in university mathematics, one could

Table 3. **Gender-based distribution of the indicators**

| Variable | Sample mean (SD) N = 159 | Mean (females) N = 102 | Mean (males) N = 57 | |
|---|---|---|---|---|
| First-year GPA | 7,79 (0,81) | 7,92 | 7,56 | *** |
| Data Science test score | 6,76 (1,87) | 6,68 | 6,90 | |
| Expectancy for success | 3,01 (0,64) | 2,91 | 3,21 | ** |
| Interest | 3,35 (0,51) | 3,34 | 3,38 | |
| Importance | 2,67 (0,80) | 2,74 | 2,54 | |
| Utility | 3,39 (0,51) | 3,42 | 3,32 | |
| Cost | 2,53 (0,58) | 2,58 | 2,45 | |

*Note:* Asterisks indicate statistically significant differences between male and female students: *** $p < 0,01$; ** $p < 0,05$.

expect that their beliefs about their capabilities, expectations and levels of anxiety associated with the course will differ. Indeed, we found differences in the levels of such motivation components as expectancy for success, intrinsic value and perceived utility (Table 4). Students in Economics showed higher expectancy for success than students in Humanities, while no significant gap was revealed between students in Sociology and Management. Students in Humanities and Management perceived the Data Science minor as less useful than students in Sociology and Economics. In addition, students in Humanities also showed less interest in the course. Average scores were found to be higher among students in Economics than among students in Humanities.

**4.2. Relationship Between Motivation and Academic Performance**

We constructed path models to explore the relationship between the motivation components and academic performance (Data Science test scores). According to our research plan, we created two models (see Fig. 1) and compared them. It turned out that Model 2 provided a better description of the empirical data, which can be seen from the fit indices (Table 5). Model 1 without control variables fitted the empirical data so badly that it was impossible to estimate the model parameters. Meanwhile, Model 2 described the data well enough even before additional variables were introduced.

The resulting model with control variables is presented in Figure 2. Expectancy for success influences academic performance directly, while interest, utility and cost only correlate with achievements indirectly, via expectancy for success. Importance plays no role at all, showing no direct or even indirect relationship with the real final scores.

Student gender affects expectancy for success, which is lower among girls, but has no effect on other motivation components.

Table 4. **Major-based distribution of the indicators**

| Variable | Economics N = 47 | Sociology N = 36 | Management and Logistics N = 40 | Humanities N = 36 |
|---|---|---|---|---|
| First-year GPA | 7,4 (0,6)** | 7,9 (0,7) | 8,1 (0,8) | 7,9 (1,0) |
| Data Science test score | 7,4 (1,8) | 6,6 (2,0) | 6,6 (2,0) | 6,2 (1,8)*** |
| Expectancy for success | 3,20 (0,57) | 3,11 (0,71) | 2,91 (0,66) | 2,81 (0,55)*** |
| Interest | 3,45 (0,52) | 3,52 (0,44) | 3,31 (0,48) | 3,12 (0,50)*** |
| Importance | 2,68 (0,71) | 2,72 (0,83) | 2,62 (0,77) | 2,67 (0,91) |
| Utility | 3,52 (0,44) | 3,57 (0,40) | 3,21 (0,55)** | 3,24 (0,54)*** |
| Cost | 2,39 (0,54) | 2,55 (0,58) | 2,53 (0,61) | 2,69 (0,58) |

*Note:* Asterisks indicate statistically significant differences between majors: *** $p < 0,01$; ** $p < 0,05$.

Table 5. **Model fit indices**

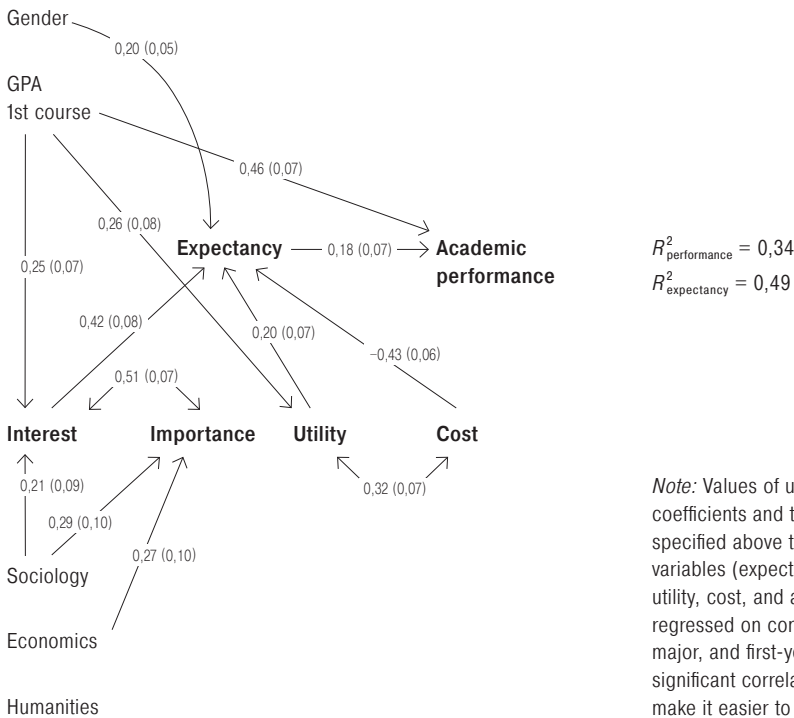| | CFI | RMSEA | SRMR |
|---|---|---|---|
| Model 1* | — | — | — |
| Model 1 with control variables | 0,806 | 0,088 | 0,090 |
| Model 2 | 0,985 | 0,051 | 0,028 |
| Model 2 with control variables | 0,995 | 0,027 | 0,035 |

* The model parameters were impossible to estimate.

Neither does it influence academic performance, i. e. the mean final course scores are the same for both male and female students.

First-year GPA correlates positively with academic performance, which is no surprise. Besides, GPA is related with some of the motivation components: the higher the GPA, the more interesting and useful the course appears to a student. At the same time, importance, cost, and expectancy for success show no correlations with GPA.

When we introduced majors into the model, we took Management and Logistics as the reference category. We performed an analysis to find out whether students in different majors had different levels of various motivation components and academic performance. Figure 2 presents the path model (Model 2 with control variables) with significant correlations only. They demonstrate that grades obtained in Data Science had more importance for students in Sociology and Economics than for those in Management and Logistics. In addition, Sociology students displayed more interest in the course than their Management and Logistics peers. By contrast, students in Humanities did not reveal any difference from students in Management.

Figure 2. **Model of relations between the motivation components and academic performance in the Data Science course**



Gender

0,20 (0,05)

GPA
1st course

0,46 (0,07)

0,26 (0,08)

**Expectancy** —— 0,18 (0,07) —→ **Academic performance**

0,25 (0,07)

0,42 (0,08)

0,20 (0,07)

−0,43 (0,06)

0,51 (0,07)

**Interest**          **Importance**          **Utility**          **Cost**

0,21 (0,09)

0,29 (0,10)

0,32 (0,07)

0,27 (0,10)

Sociology

Economics

Humanities

$R^2_{performance} = 0,34$

$R^2_{expectancy} = 0,49$

*Note:* Values of unstandardized regression coefficients and their standard errors are specified above the arrows. The basic model variables (expectancy, interest, importance, utility, cost, and academic performance) were regressed on control variables (gender, current major, and first-year GPA). Only statistically significant correlations were left in the figure to make it easier to understand.

The final model (Fig. 2) explains 34% of the variance in academic performance, with interest, utility and perceived costs collectively explaining 49% of the variance in expectancy for success.

**5. Discussion**     This paper explores how the motivation of students affects their performance in the Data Science course. The course belongs with the group of academic disciplines referred to as STEM (Science, Technology, Engineering and Mathematics) and also with statistics. Both mathematics and statistics are believed to be difficult subjects, and numerous studies have been devoted to mathematical and statistical anxiety, which is also related to gender stereotypes in education [Emmioğlu, Capa-Aydin 2012; Hood, Creed, Neumann 2012]. There are two scientific journals, *Statistics Education Research Journal* and *Journal of Statistics Education*, which specialize in statistical education and publish papers similar to this one. Thus, our work is integrated in research on attitudes and stereotypes that make the learning of many STEM subjects challenging.

It is one of the distinctive features of this case that the course was largely *terra incognita* for all students when they were choosing their

minor, and motivations could differ from student to student as well as from major to major. When students move passively through compulsory courses, which is typical for Russian universities, they may have no motivation for learning a specific course. In our case, they were responsible for electing a course that differed from their major, being guided by certain beliefs and expectations—which could later turn out to be false and require corrections in the learning process, and a re-valuation of cost and utility. It makes the situation as similar as possible to the practice of elective courses adopted in the Anglo-Saxon education system.

Another distinctive feature of this course is the active integration of computer technology into the learning process: opportunities of out-of-school access to the virtual learning environment, a special forum for online panel discussions on the issues arising when students work independently, access to supplementary materials on the server, etc. Development of online learning and active integration of computer technology into the learning process have a double effect: it increases student involvement and provides individualizes learning, and at the same time makes it possible to obtain information on student engagement and effort [Barba, Kennedy, Ainley 2016].

In this paper, we managed to explore the structure of motivation and fit a model to describe the relationship between the different motivation components in a group of students, heterogeneous in many ways, who started attending the Data Science course. The model explains 34% of the variance in academic performance, proving that motivation significantly contributes to education outcomes.

Meanwhile, our model shows that subjective task values only influence academic performance indirectly, via expectancy for success, which makes it different from the classic model of Jacquelynne S. Eccles, where performance is directly affected by values. In this respect, our findings appear to be closer to Albert Bandura's idea that perceived self-efficacy is a crucial factor affecting academic achievements, being in turn influenced by various contributory factors [Bandura 1993].

Apart from motivation, performance in the minor is also influenced by previous academic achievements, notably first-year GPA. Like many educational researchers [Bretz 1989; Kuncel, Hezlett, Ones 2001], we believe that GPA is an adequate indicator of academic performance that reflects student's cognitive abilities as well as zeal and self-discipline, so new difficult courses are easily mastered by those who performed well during previous years. This observation was true even when majors were controlled in the model, i. e. students in Economics had no advantage over those in Humanities. At the same time, first-year GPA did not affect self-confidence in any way, yet students with better grades expressed more interest in the course and perceived it as more useful for their future career.

The gender effect—which is that girls tend to assess their abilities lower than boys, despite the absence of any meaningful gap in edu-

cational outcomes—we explain by gender stereotypes, as in a number of other studies [Abraham, Barker 2015; Meece et al. 2006]. However, there is hope that gender disproportions in expectancy for success will be gradually reduced, given the fact that girls accounted for 64% of the students who registered for the Data Science course, as well the absence of gender-related differences in academic performance.

An important finding is the prevalence of intrinsic value (interest) over attainment value (importance). We believe that this is a distinctive feature of elective courses, which make students feel more responsible than compulsory ones. In this respect, it should be admitted that the practice of introducing minors and allowing students of all majors to choose any available minor proved to be successful.

We revealed no association between major and Data Science test score. Because the curricula of different majors include different amounts of mathematical and logical courses, one could expect that Economics students should be better prepared for the course than students in Humanities, yet no such effect was observed. This can be explained to some extent by self-selection of students in Humanities majors: the low percentage of those opting for Data Science may indicate that only the most prepared registered for the minor.

The relation between academic performance, previous training and motivation that we established in this study deserves close examination, given the widespread prejudice that the "advanced" use of modern data science technology is not available to everyone and is impossible without a solid mathematical background.

Studies similar to ours have a practical importance. Using statistically justified models, they help find ways of assisting students in mastering difficult courses on which they have formed some biased opinions. Our findings demonstrate that motivation, especially self-confidence, is extremely important even when the effect of previous achievements is taken into account. Unlike cognitive abilities, beliefs about oneself and one's own capacities can be corrected. Correction of gender and occupational stereotypes as an integral step towards developing the motivation for learning may be an essential component of university education, providing students in all kinds of majors with the opportunity to master competencies demanded in the modern labor market.

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