COVER PAGE (to be added)

FORECASTING THE TEACHING WORKFORCE IN LITHUANIA

FINAL PROJECT REPORT

This report describes a pilot project set up to develop a teacher workforce planning system in Lithuania. It provides information on the proposed teacher planning cycle and its major elements. The framework of the forecasting model, the main methodological aspects and results are presented. Three different scenarios on short and midterm teacher needs are provided. Conclusions and recommendations for the further development of the system and for the teacher workforce size are provided.

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GLOSSARY

CPD – Continuous Professional Development

FTE – Full Time Equivalent

HE – Higher Education

HEI – Higher Education Institution

ITT/E – Initial Teacher Training/ Education

MOSTA – Higher Education and Research Monitoring and Analysis Centre

NHRMS – National Human Resource Monitoring System

NQT – Newly Qualified Teachers

PISA – the Programme for International Student Assessment by the Organisation for Economic Co-operation and Development (OECD)

STEM – Science, Technology, Engineering and Mathematics

SRSS – Structural Reform Support Service, European Commission

TSM – Teacher Supply Model, Department for Education, England

Weighted unique – an indicator used to measure the net number of individuals per specialisation. Weights for teachers teaching different teaching subjects are attributed. Weights for students studying different teaching subjects are attributed. For example, if an individual teaches Mathematics and IT, then 05. and 0.5 weights are attributed respectively.

Specialisation – an element that describes teaching subject or duty at school, for example "Mathematics teacher" or "Psychologist". There are 29 specialisations within the model scope. Specialisations are not distinguished by school type, for example, teachers teaching Mathematics in either general education or vocational schools fall under the same specialisation "Mathematics teacher".

INTRODUCTION

This pilot project, to develop a teacher workforce model, was commissioned by the Office of the Government of Lithuania and the Ministry of Education and Science as part of ongoing reforms of the education system. Wide-ranging reforms of the systems of management, career planning and financing of education and science in Lithuania are currently being implemented. One of the priorities of the reform agenda is "The Development and Implementation of Career and Professional Training System for Teachers". In this context, a project group was assembled and technical support was requested from the European Commission. Project team members from the Ministries and the Research and Higher Education Monitoring and Analysis Centre (MOSTA) worked together with experts from the Structural Reform Support Programme of the European Commission, the Department for Education in England and University College Cork in Ireland throughout the project timeline.

Planning teacher demand and supply is one of the central concerns in education. Anticipating shortages in specific teaching subjects and/or other areas of education in the future is crucial for the preparation and implementation of initial teacher training programmes. In order to accommodate demographic and other exogenous challenges, strategic decisions need to be made well in advance. Teachers are key to the learning process, therefore, projecting the size of the teaching population that needs an investment in preparation, skills and continuous support is important. By steering strategic decisions towards quality in teaching, policy-makers strive to ensure that all children in the future receive learning opportunities in the most efficient way.

The aim of the teacher workforce planning project is to set up a pilot forecasting model that provides short term and midterm forecasts on teacher demand. The pilot project aims to find solutions for an annual working cycle that incorporates processes such as data collection, model renewal, stakeholder consultation and other essential system elements. The goal of the system is to provide insights and recommendations on the future teaching workforce that accommodates changes in pupil numbers, ageing teaching population and other changes in the most efficient way. Based on the forecasting results, policy recommendations are provided.

This project contributes to the series of measures used to inform decision-making in educational planning in Lithuania. In addition, it aims to strengthen the culture of transparency among the educational community and to open a platform for dialogue. The project team strongly believes that decisions undertaken must be based on evidence that is clear and thoroughly explored with the system stakeholders. During the course of the pilot project, a series of events, workshops and discussions were held to which the various stakeholders were invited. The project team hopes that this approach has provided a solid basis for consultation for the future.

The first section of the report sets out the challenges faced by the education community and provides a background on the education system and teaching profession in Lithuania. Section 2 provides information on the project design, major system elements and forecasting model framework. Core model assumptions are presented in Section 3. Foreign modelling examples and a literature overview is given in Section 4. Finally, Section 5 provides forecasting results and scenarios.

EXECUTIVE SUMMARY

The population of Lithuania has been declining in recent years and fell to 2.8m in 2017. Demographic trends in Lithuania are negative and, unless unexpected changes occur, do not look promising. According to projections prepared by Eurostat, the population of Lithuania will shrink to 2,67m in 2020 and will fall even further in 2030 and 2040 (to 2,2m in 2030 and to 1,2m in 2040)[1].

The demographic changes of the past decade have been reflected in the total pupil population, which has experienced a 5 percent decrease between the school years 2012-2013 and 2016-2017. The biggest decrease in pupil numbers can be seen in lower secondary and upper secondary education indicating that in two to three years' time, the number of pupils in the final school grades will fall significantly. However, there have been increases in pupil population at ISCED levels 0 (pre-primary) and 1 (primary) indicating that the school population will grow to some extent in the coming years.

Another central aspect of the teacher profession in Lithuania is the age of teachers. The teaching workforce is rapidly ageing; nearly half of general education teachers are 50 years and older. The most typical age group is 50-59 which represents 37 percent of teachers. Unlike other EU countries, teachers in Lithuania do not have to retire from teaching when they reach the retirement age. Approximately 6 percent of working teachers are already at retirement age as of the school year 2016-2017[2]. If the current trend continues, 20 percent of the teaching workforce will be beyond retirement age in 5 years' time. The ageing workforce is a national issue, covering almost all regions.

Most replacement teachers are recruited from students graduating from initial teacher training (ITT) programmes at higher education institutions. The number of such students has declined significantly over the last 5 school years. A very large proportion of students entering ITT programmes drop out before graduation and in recent years, of those who graduate, fewer than 15% entered the teaching profession immediately on graduation.

Teaching is not regarded as an attractive profession in Lithuania. Since a significant proportion of teachers, especially specialist subject teachers in rural schools, teach fewer than 18 hours per week, the average salary of Lithuanian teachers is among the lowest in the EU.

Recent reforms of the Lithuanian education system have been introduced to improve the situation of the teaching profession. A revised teacher training model, including an induction period, was drawn up in 2018. Under this model, experienced teachers will have an opportunity to mentor new teachers and get paid for this new official role. More clear pathways towards acquiring a qualification in teaching are defined through both consecutive and concurrent study programmes.

Along with changes in teacher training and in the career development system, ITT is being consolidated by establishing three Centres of Excellence. Three public universities, Vilnius University, Vytautas Magnus University and Šiauliai University along with their partners from Colleges, have agreed to lead and form the basis for Centres of Excellence in teacher training in Lithuania.

A crucial proposed change is in the teacher payment scheme. According to the Ministry of Education and Science[3], one third of teachers in Lithuania earn only 430 EUR net per month due to the low official number of hours worked. Until now, teacher payment was based on an hourly rate, leaving many teachers paid and employed on a part-time basis. Moreover, other education-related activities, undertaken in addition to classroom teaching, were not accounted for. A major reform of the system whereby all teachers will be paid on a full-time equivalent basis, has been agreed and has begun to be implemented in 2018.

[1] Statistics Lithuania (28th November, 2014), *On Lithuanian population projections,* Official Statistics Portal. https://osp.stat.gov.lt/en/informaciniai-pranesimai?articleId=3012667
[2] Unlike some other EU countries, teachers in Lithuania are not required to retire when they reach retirement age.
[3] LR Švietimo ir mokslo ministerija, Informacinis vaizdo filmukas, www.etatinis.lt

In the context of this project, the aim of which was to develop a computerised teacher workforce model for Lithuania, the literature on teacher workforce models internationally as well as research on the issue by Lithuanian academics, was scoped and a summary of the results are included in this report. A sophisticated interactive computerised teacher forecasting model developed by the Department for Education in England was examined and was found to be both relevant and useful. The experience of teacher forecasting in Ireland where the development of a reliable teacher/supply model is ongoing, was explored.

The teacher forecasting model described in this report, is based on data currently available relating to teacher supply and demand in Lithuania. Detailed statistical data was available on levels and sectors of teachers, their specialisations, the municipalities in which they taught, the number of hours taught and the age and gender of the teachers. On the supply side, the team had access to data on pupil numbers by age and municipality, the likely output of ITT graduates by specialisation and other relevant information. While the data available enabled the team to produce the basic elements of a teacher supply/demand model in a relatively short period of time, further work will be required to develop a more sophisticated model which will ensure the reliability and validity of the forecasting results.

The team would like to emphasise that their results and findings at this stage are tentative and their accuracy will depend on a number of factors beyond their control, including the implementation of proposed policy reforms. In order to highlight the flexibility of the model and the tentativeness of the findings of the most likely scenario, set out in Section 5.1., the report presents projections based on two alternative scenarios in Section 5.2., referred to as high efficiency (HE) and low efficiency (LE) scenarios.

Based on the most likely scenario, the model forecasts that 3077 teachers who worked at schools in 2017-2018 will leave due to retirement within the next 4 years. The largest number of teachers likely to retire are pre-school tutors (680) and primary education teachers (306).

A challenge to the supply side of the teaching workforce is the low graduation and employment levels of ITT graduates in Lithuania. The total pool of ITT students within the 4-year period is 848. However, based on historical information on student graduation and career take up (employment at schools), only 13% of graduates are expected to start working in schools immediately after graduation. Taking account of drop-out and low employment rates, it is forecast that only 126 ITT graduates are likely to enter schools in 2018/19.

Shortages of over 20 individuals are forecast in specializations such as Lithuanian language (24), Mathematics (25), Other foreign languages (29), Grade 0 (55) and Psychologists (109). A surplus for Social educators (37) and Pre-school tutors (284) in 2018/19 is expected. The highest shortage of teachers is likely to be at primary school level (177). Even if all ITT graduates receive employment, there would be a shortage of over 100 teachers.

The highest cumulative 4-year shortage can be seen in Primary school teachers, which adds up to approx. 700. If an earlier start of primary education is to be implemented and pupil participation in preschool education is to increase in rural areas, there is a risk of an even higher shortage in teacher numbers in those sectors. Other shortages in Lithuanian language and Mathematics might reach up to 200 individuals over a four-year period. The shortage of pre-primary teachers is likely to reach approximately 123. Due to differences in cohort sizes, the overall surplus for pre-school tutors will reduce to 229 in 4 years. Foreign language teachers (English and Other) will face a shortage of 171 and 159 respectively. All three scenarios forecast shortages for primary and pre-school teachers in 2018/19.

Based on the work of the team and on the findings of this report, some recommendations and suggestions are made. These include the following:

- A group (e.g. a Steering Committee) should be set up, coordinated by the Ministry of Education and Science, that would routinely meet to ensure teacher planning practice and implementation of the processes needed to gather all necessary information and data. This group might include representatives of the Ministry of Education and Science, of the teaching profession, of municipalities, and of ITT Centres. The suggested involvement of the newly established ITT

centres in the suggested collaborative teacher workforce planning team will provide a platform for engaging them in the change process.

- Regular and ongoing forecasting of pupil numbers will be needed to determine, inter alia, whether the increases in cohorts of young children are temporary or will continue for a longer period of time.
- Measures being introduced to improve pay and working conditions for teachers should be monitored to measure their impact on entry to ITT, dropout and graduation rates and employment levels.
- A survey of student attitudes should be conducted to identify the reasons for current ITT student dropout rates.
- Retirement incentives for teachers should be reviewed. Retirement should be an economically attractive option for teachers who are willing to retire.
- Large numbers of ITT graduates who chose not to work at schools indicate that there is a pool of individuals who were once motivated to become teachers. Programmes dedicated to encouraging such individuals to enter the teaching workforce might be introduced.
- The need for more teachers in preschool, pre-primary and primary education should be prioritised.
- Further development of the forecasting model will be required to incorporate all the data and information necessary for a comprehensive teacher workforce model.
- In the case that any of the above recommendations have resource implications – the necessary resources should be made available.

1 BACKGROUND AND CONTEXT

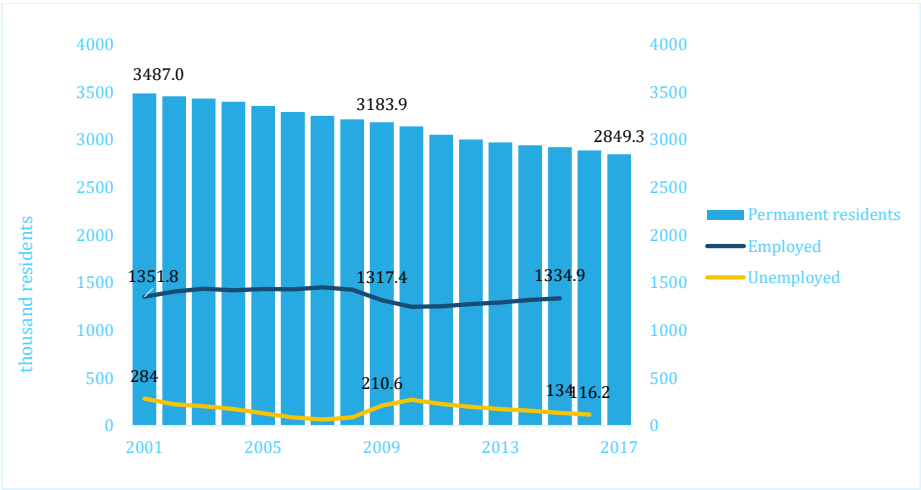
The following section sets out the background and helps readers to understand the demographic and educational challenges that are faced in Lithuania. The information also provides basic knowledge on the ongoing education reforms that are designed to overcome those challenges. In addition, information on the education system and teacher profession is provided. This section will help to explain some choices that were made in designing the teacher need planning system and the quantitative forecasting model.

1.1. CHALLENGES ADDRESSED

NATIONAL CHALLENGES IN DEMOGRAPHICS

To set the background to the development and challenges of the teaching profession in Lithuania, it is first of all necessary to understand the demographic changes in Lithuania. The number of permanent residents has been gradually declining in recent years and fell to 2.8m in 2017. The most significant changes in employment were seen during the recession in 2009-2017. Employment is now growing back to its initial pre-recession level, however it has not peaked yet. During the last 10 years, employment grew only in the districts of Vilnius and Klaipėda; the rest of the population living in regional, rural areas still suffer from lower employment opportunities.

Figure 1. Number of permanent residents, employment and unemployment figures in Lithuania, 2001-2017



Emigration has been a key factor in the decreasing population of Lithuania. Recent migration figures show a continuing trend in the number of individuals leaving the country. Furthermore, monthly immigration has been fluctuating at around 2000 individuals between 2014 and 2017 and is not increasing at a high enough pace to compensate for the rapid decrease in population. In addition, there have been approximately 2500 monthly births in Lithuania in the same period (2014-2017) which is lower than the monthly death rate of approximately 3000. Therefore, demographic trends in Lithuania are negative and, unless an unexpected change occurs, do not look promising. According to the main

scenario of the population projections prepared by Eurostat, the population in Lithuania will shrink to 2,67m in 2020 and will fall even further in 2030 and 2040 (2,2m in 2030, 1,2m in 2040)[4].

Figure 2. Monthly migration trends in Lithuania in 2014-2017

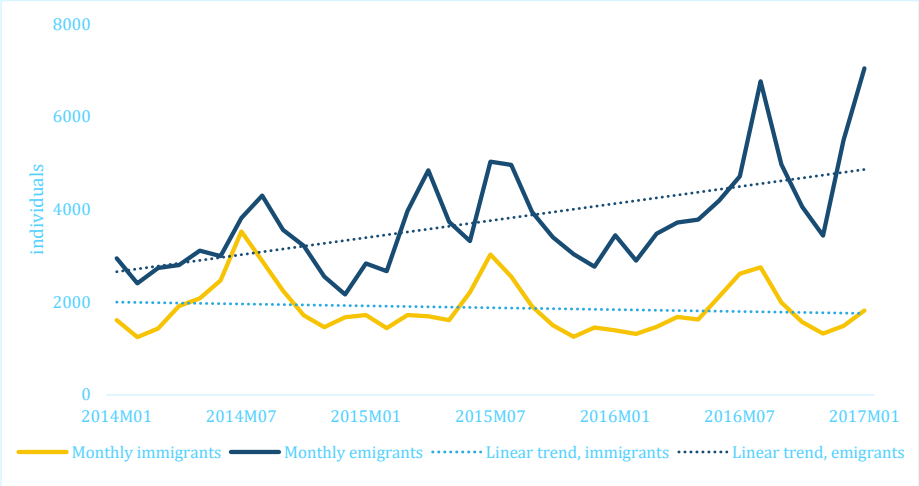
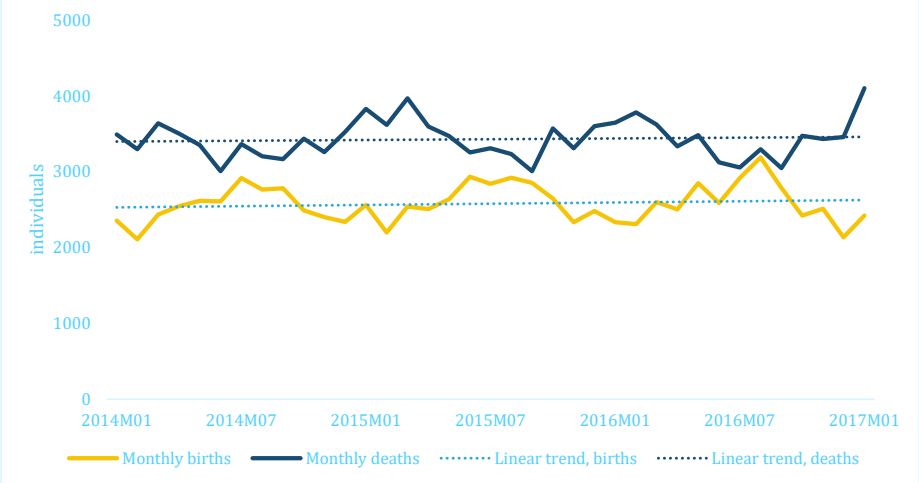


Figure 3. Natural monthly population increase in Lithuania, 2014-2017

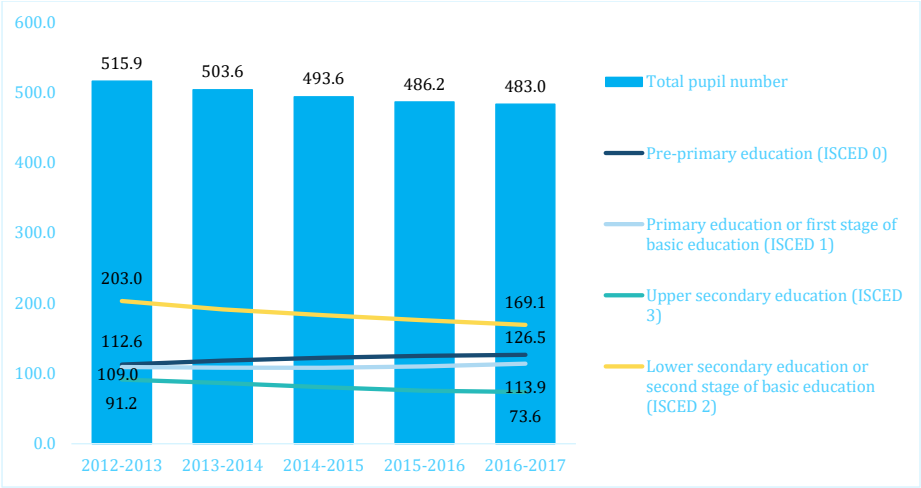


The demographic changes of the past decade have been reflected in the total pupil population, which has experienced a 5 percent decrease between the school years 2012-2013 and 2016-2017. The biggest decreases in pupil numbers can be seen in lower secondary and upper secondary education indicating that in two to three years' time, the number of pupils in the final school grades will fall significantly. In contrast, there have been increases in pupil population at ISCED levels 0 (pre-primary) and 1 (primary)

[4] Statistics Lithuania (28th November, 2014), *On Lithuanian population projections,* Official Statistics Portal. https://osp.stat.gov.lt/en/informaciniai-pranesimai?articleId=3012667

indicating that the school population will grow in the coming years. This indicates two things: first, that there is likely to be a need for additional pre-primary and primary teachers; and secondly that assuming that the curriculum and teaching subject distribution remain constant, older cohorts will require more teachers in some teaching subjects at higher grades. The recent declining number of pupils put pressure on the school network resulting in some closures and consolidation, raising many discussions in the society. Due to the recent decreasing numbers of pupils, the pupil-teacher ratio in Lithuania is below average OECD figures.

Figure 4. Pupils in pre-primary and general education by ISCED level and school year in Lithuania, 2012-2017



Another central aspect of the teacher profession in Lithuania is the age of teachers. The teaching workforce is rapidly ageing; nearly half of general education teachers are 50 years and older. The most typical age group is 50-59 which represents 37 percent of teachers. Approximately 6 percent of working teachers are already at retirement age as of the school year 2016-2017[5]. If the current trend continues, 20 percent of current teaching workforce will have reached retirement age in 5 years' time. The ageing workforce is a national issue, covering almost all regions. Teachers in 30 percent of municipalities are on average older than 50 years of age. The age structure of the teaching workforce with a significant over-representation of staff older than 50 years of age could lead to teacher shortages in the years ahead.

Many teachers who are beyond the retirement age but still working at schools will need to be replaced soon. Most of this replacement will be needed in Natural Science (Biology, Chemistry, Physics) as well as history and other subjects, where elderly teachers dominate across municipalities of Lithuania. In 30 percent of municipalities Chemistry has the highest share of working "retirement age" teachers, in 20 percent – Physics.

To complete the picture, it is important to point out that Lithuania's teaching workforce is primarily female-based. In comparison with the OECD average of 84 percent, 97 percent of primary school teachers were female (2015). At upper secondary level, approximately 79 percent of teachers are female compared to the OECD average of 59 percent[6].

[5] Unlike some other EU countries, teachers in Lithuania are not required to retire when they reach retirement age.
[6] OECD (2017), *Education in Lithuania*, Reviews of National Policies for Education, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264281486-en

Figure 5. General education teachers by age group, school year 2016-2017

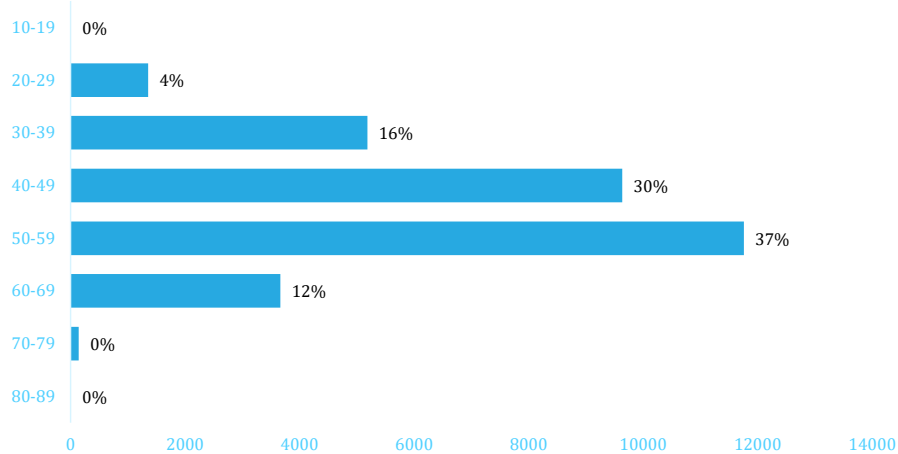
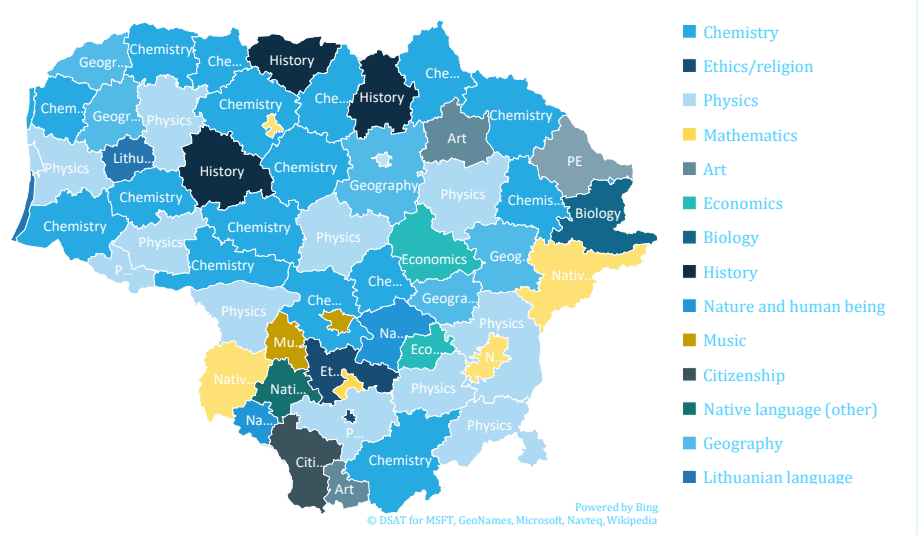


Figure 6. Municipalities by subject, which share of working retirement age general education teachers is the highest, school year 2016-2017



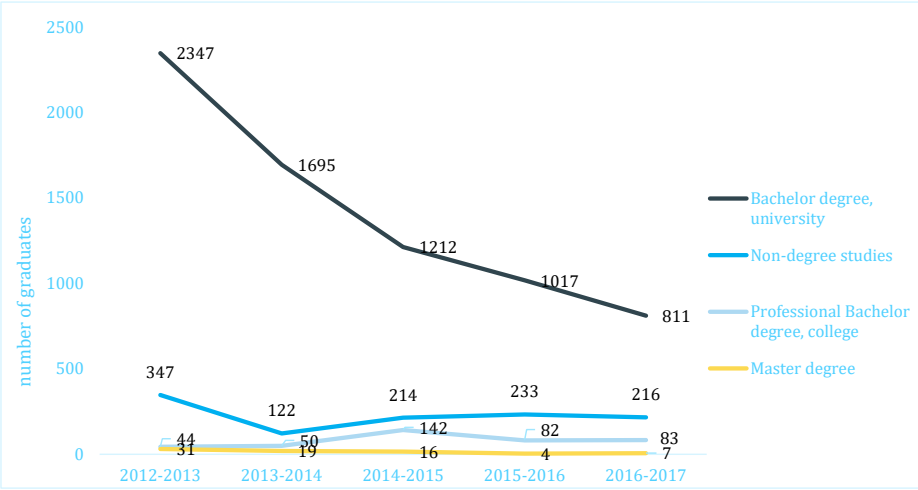
TRAINING AND CAREER DEVELOPMENT

Another challenge to be addressed in this report is initial teacher training. Most replacement teachers are recruited from students graduating from initial teacher training programmes at higher education institutions. The number of students graduating from initial teacher training programs has declined significantly over the last 5 school years. The number of university bachelor degree students graduating from programmes providing teaching qualification decreased almost threefold. One source of this decrease is the declining number of the total 1st year students enrolling in HE programmes. Furthermore, there is little interest in subject-specific training programmes. Anecdotal evidence indicates that only 32 Chemistry graduates received teaching qualification in the past five school years. As has been noted in

Figure 6 (above), the greatest proportion of teachers working beyond retirement age are Chemistry teachers in 30 percent of municipalities. Furthermore, only a small proportion of new graduates seek and find employment at schools. Only approx. 30 percent of students who enrolled to a pre-school teaching programme successfully graduated and started working at schools following graduation. The challenges listed above and other challenges contribute to a replacement problem that schools are facing or will face shortly.

Teachers and society generally in Lithuania face systemic challenges that impact their everyday life and the general image of the teaching profession. Teachers face low official workloads (as measured in contact hours) and therefore, difficulties in acquiring hours equal to a full-time equivalent post. Decentralized decision-making system leaving autonomy to municipalities and school principals does not protect teachers from fluctuations in schooling hours. For this reason, many teachers earn very little and have to work in more than one school. With no school experience and ranks, young teachers and recent graduates have little chance of receiving enough contact hours to earn a living. According to the European Commission[7], the minimum (and maximum) basic gross annual statutory salary level of teachers in Lithuania in relation to GDP per capita is lower than in all other EU nations.

Figure 7. Number of graduates with professional qualification in teaching, 2012-2017



[7] European Commission/EACEA/Eurydice, 2016. *Teachers' and School Heads' Salaries and Allowances in Europe – 2015/16*. Eurydice Facts and Figures. Luxembourg: Publications Office of the European Union.

PUPIL ACHIEVEMENT

A crucial aspect indicating teacher quality is pupil achievement. Even though the coverage and participation in formal education is wide spread, previous PISA tests (2015) have shown that pupils in Lithuania do not demonstrate high performance levels. Learning outcomes of Lithuanian pupils have been below OECD averages in the PISA tests of 2009, 2012 and 2015. When comparing science literacy, 15-year-olds score 475 points compared to a 493 OECD average (2015)[8]. Similar gaps can be seen for mathematics (478 vs. 490) and reading (472 vs. 493). Significant differences between boys and girls can be seen in mathematics and reading with girls performing better than boys. Very few pupils perform at a high level in Lithuania; most of the pupils perform at low proficiency levels. Looking at performance in science, only 9.5 percent of Lithuanian students perform at top levels whereas the OECD average is 15 percent[9].

Furthermore, significant disparities between achievers in rural and urban areas can be seen. As reported by the OECD, urban students scored 57 points more in mathematics compared to rural students, which is the equivalent of one year of schooling. All in all, no significant improvements in pupil learning achievements have been seen since 2009 leaving a large gap between urban and rural learning outcomes.

The scope of this project is to create and implement a teacher workforce forecasting model. Up to now, there has been no systematic mechanism to project teacher workforce requirements or to set quotas for publicly funded study placements for initial teacher training. Given the high average age of current teachers, low ITT programmes' admission rates and changes in pupil population it is expected that there will be an undersupply of teachers in Lithuania soon. The mismatch between supply and demand in the teaching workforce affects the whole educational system and labour market for teachers. Teachers in Lithuania face many external and systematic challenges that need to be addressed in order to attract and retain talents, and to attract a new generation of teachers. Therefore, there is a need to systematically estimate and forecast the demand for teachers based on socio-economic and demographic trends, which will allow policy decision to be made relating to admission quotas to ITT programmes.

RECENT POLICY REFORMS

Modern societies are facing rapid changes in the learning environment. To accommodate cultural and linguistic diversity, changes in skillsets demanded, learning approaches and other needs in education we must foresee future trends and use them in a beneficial manner. Modern educational systems must attract the most suitable candidates for teaching, equip future teachers with what they need to know and do, deliver effective training programmes and provide continuous support for them throughout the teaching work cycle.

There are four main tasks in reshaping and enhancing teaching both as a profession and from a wider educational perspective. Firstly, it is essential to improve the quality of education which is now being reflected by the worsening pupil achievements and decreasing societal trust in formal education. A new generation of teachers, a new vision for teacher training programmes and enhanced prospects for employment are crucial to increase enrolment to ITT centres. Solutions to tackle the ageing teaching workforce and the imbalance in teaching subjects are needed to overcome demographic and other related challenges. Furthermore, employment perspectives both for new and experienced teachers have to be reviewed and renewed to tackle low official workloads and salaries currently being paid.

Policy initiatives to address these issues have been under way for several years now. The concept of a "good school" was agreed in 2015. The educational community agreed on school-level and individual-level outputs that describe a "good school".

[8] Education GPS, *OECD*, 7/31/2018, 4:45:52 PM http://gpseducation.oecd.org
[9] OECD (2017), *Education in Lithuania*, Reviews of National Policies for Education, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264281486-en

Another important milestone was the revised teacher training model prepared in 2017. For the first time a model describing a unified process of teacher training and continuous professional development was prepared and introduced. Although the core model elements have been approved, implementation steps still need to be taken. To ensure the professional and personal development of a starting teacher, an official induction period is being introduced. In addition, experienced teachers will have an opportunity to mentor new teachers and get paid for this new official role within or outside their school community. Continuous professional development (CPD) starting from student selection during admission, through the ITT phase, up until retirement is clearly defined. Guidelines on student motivational interviews that draw on personal qualities concerning teaching profession, values and academic potential are set out in the model. In addition, it has been agreed that ongoing and continuous analyses of education, changes in curriculum and teacher demand are needed. More clear pathways towards acquiring qualification in teaching are defined through both consecutive and concurrent study programmes.

Along with changes in teacher training and career development system, competences and best practice in training young talents are being consolidated by establishing three Centres of Excellence. Three public universities, along with their partners from Colleges, have proposed and were chosen to establish or/ and strengthen their capacity in training teachers, research and building an educational network. Vilnius University, Vytautas Magnus University and Šiauliai University agreed to lead and form the basis for Centres of Excellence in teacher training in Lithuania. The role of these centres is to identify and apply good practice, thereby implementing and enhancing modern teacher training; to collaborate with municipalities and schools to support newly-qualified teachers during their induction period; and to become leaders in up-to-date research in educational innovations.

Another crucial change is in the teacher payment scheme. According to the Ministry of Education and Science[10], one third of teachers in Lithuania earn only 430 EUR net per month due to the low official number of hours worked. A major reform of the system has been agreed and has begun to be implemented in 2018. To attract young talent into the teaching profession, to ensure social security and stable job opportunities and income, the Ministry of Education and Science, together with other governance stakeholders and educational community, has agreed on a new teacher payment scheme. Up until this reform, teacher payment was based on an hourly rate rather than on a full-time equivalent basis, leaving many teachers paid and employed on a part-time basis. Moreover, other education-related activities, undertaken in addition to classroom teaching, were not accounted for. To address these challenges and to work towards the goals described above, a new system of teacher payment is being implemented at the time that this report is being written.

The new payment scheme lists two types of job contracts available – a contract for a beginner- teacher and a contract for more experienced teachers. Both contracts will ensure work for 36 hours per week. Beginner- teachers will get paid for 756 contact hours per year, non-contact hours and additional time dedicated to the school community and their career development including induction. An experienced teacher is expected to undertake 1008 contact hours per year, as well as non-contact hours and additional time for mentoring and training younger teachers who need orientation in their every-day school tasks and career development. It is expected that the new payment scheme will provide opportunities for more after-class activities and consultations and will lower the amount of money and time parents currently spend on private tutors.

Recently, in 2016, mandatory one-year pre-school education was introduced, and the government decision to lower the age (starting at 6) for primary education has raised the demand for pre-school teachers in the context of a national oversupply of primary teachers. At the same time, it means that lower secondary education students will be starting their education at a very young age. Thus, there is a need not only to forecast the demand for teacher training, but also to take into account necessary changes in third-level provision to provide, for example, a wider profile of pre-primary and primary

[10] LR Švietimo ir mokslo ministerija, Informacinis vaizdo filmukas, www.etatinis.lt

teacher qualification. This should enable teacher mobility between pre-school and primary education, primary and lower secondary education.

Another change is related to the more integrated, modern school curriculum which will impact on subject teacher demand. With the current drop in pupil population, the lowest pupil-teacher ratio is in the lower secondary education, but because of the many curriculum subjects there is a need for many teachers of different subjects to cover the curriculum adequately. Traditionally, teachers acquire one subject qualification, and due to this, subject teachers' work load is limited, especially in small rural schools. Thus, there is a need for forecasting which is not based on a traditional one-subject-teacher training, but on plans for reforms, recent and future.

Several European Social Fund supported projects have been used to support and to implement recent changes and reforms. A pilot project on induction and its implementation, activity evaluation, additional competences and qualifications for employed teachers are being run by the Education Development Centre. A project on opportunities for various profile teachers willing to pursue advanced higher education is being planned. Other initiatives include Structural Reform Support Service (SRSS) projects on forecasting the needs for teaching workforce and teacher training centre network creation; European Schoolnet: Initial Teacher Training Lab; Teacher Selection Project; Erasmus and Twinning projects.

1.2. EDUCATION AND TEACHER PROFESSION IN LITHUANIA

This subsection will provide information on the education system in Lithuania. In addition, information on teacher employment, qualification requirements, training types and retirement system will be given.

EDUCATION SYSTEM IN SHORT

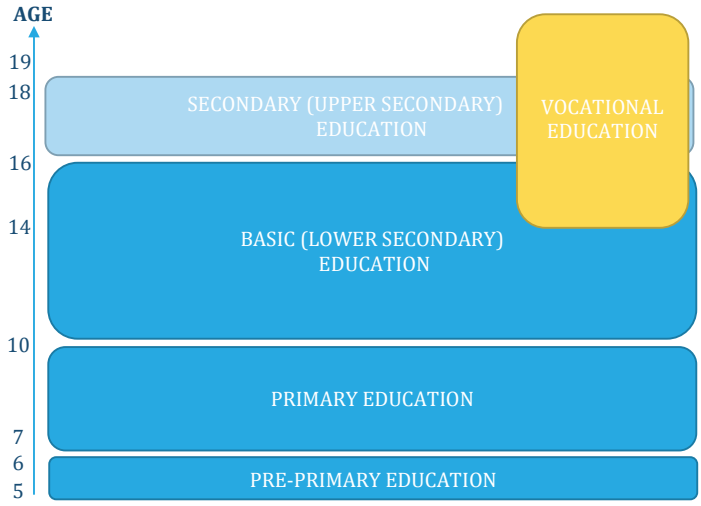
General education system in Lithuania is divided into 3 main stages:

- **Primary education.** Primary education starts at the age of 6-7 and is compulsory. It takes 4 years to finish primary education by acquiring skills in elementary literacy and numeracy and developing cognitive and other skills.
- **Basic education (lower secondary).** Basic education in Lithuania is compulsory up until the age of 16-17 and lasts for 6 years. Pupils are taught a variety of subjects including languages, mathematics, arts, social education, IT and other. Pupils who successfully finish basic education (lower secondary) receive a Certificate of Basic Education.
- **Secondary education (upper secondary).** Those who successfully complete basic education can further follow a secondary education cycle that lasts for 2 years until the age of 18-19. Even though (upper) secondary education is not compulsory, only a very small proportion of pupils decide not to continue with education. At upper secondary level, pupils are able to design and choose subjects more freely according to their needs and interests. To successfully finish secondary education and receive a diploma "*Brandos Atestatas",* pupils have to take *matura* exams.

Since 2016 children must start their education at a pre-primary year aged 5-6 and this year is free of charge. Other pre-school education institutions are not compulsory but participation rates are high, especially in urban municipalities. Basic and secondary education programmes can be also taken at vocational education schools. Upon acquiring *Brandos Atestatas* higher education is available in both colleges and universities. There are several types of schools conducting general education programmes across the municipalities of Lithuania. Currently the school network consists of 1064 public and 61 private general education schools. There are 73 public and 3 private vocational schools[11].

[11] Number of Educational Institutions, Statistics Lithuania, 2018

Figure 8. General education structure in Lithuania



TEACHERS IN LITHUANIA: EMPLOYMENT AND OTHER WORK STRUCTURE SPECIFICS

Qualification requirements

General and pre-school education teachers in Lithuania must have a higher education degree (at least Bachelor) and a professional qualification in teaching. Teachers in basic and secondary education are trained to teach a specific subject, whereas those willing to teach at primary level study to teach all subjects. The exact contents of training programmes are selected and defined by the HEIs themselves.

Teachers who teach profession-related subjects in vocational schools are required to have at least secondary education and a qualification in teaching or must have finished a course in pedagogics and psychology. However, teachers who teach general education subjects at vocational schools are required to have higher education the same as teachers working in general education schools.

There are specific requirements set for teachers who wish to teach a specific subject. Requirements are defined and set by the Ministry of Education and Science. One must have a HE diploma in a specific study field (and, in some cases, branch of a study field) in order to teach a specific subject. For example, teachers in Mathematics must hold a degree in the study fields of Mathematics, Statistics or Pedagogy of Mathematics. Some exemptions in qualification requirements exist for teachers of optional subjects with a requirement for a course/ECTS on the relevant specialisation like, for example, Economics.

General education school principals are hired on a 5-year basis. School principals must have a higher education degree and must satisfy at least one of the following requirements: 1) qualification in teaching and least 3 years of teaching experience; 2) hold a Master's degree, teaching qualification and at least 3 years of teaching experience; 3) satisfy a higher professional qualification level, experience and a qualification in management of education. There are different qualification requirements for a principal of a vocational school, as well for a principal of a non-formal education institution.

Other school staff such as psychologists must hold a Bachelor and a master's degree in psychology or a professional Psychology qualification received with a higher education degree. Social pedagogues must have acquired a professional social pedagogue degree that is available in higher education institutions

only. Social workers who have a qualification in teaching are allowed to work as a social pedagogue at school. A school speech therapist must hold a higher education degree and a professional qualification in speech therapy. Qualification requirements for other school staff are set by the Ministry of Education and Science.

Initial teacher training

There are a few pathways towards teaching in Lithuania. General education teachers must have a higher education degree, therefore, all ITT programmes are being conducted by either colleges or universities. Most of the ITT programmes grant a HE degree and a professional qualification. There are two types of programmes: consecutive and concurrent.

As of the school year 2017-2018, there are 96 ITT study programmes of which 69 Bachelor and 18 Master are concurrent studies; 9 are consecutive programmes. Out of 10 universities there is a music and theatre academy, an art academy and a sports university. 5 universities and 1 college are located in Vilnius, 3 universities and 1 college are located in Kaunas. Both Klaipėda and Šiauliai have 1 university and 1 college each. The rest of the colleges are located in Marijampolė, Panevėžys and Utena. The total number of institutions, study programmes and students enrolled by institution type and programme level are summarised in Table 1.

Table 1. Number of institutions, study programmes and enrolled ITT students in school year 2017-2018.

	Bachelor	Master	Professional studies
Number of institutions			
College	7	-	-
University	8	4	9
Number of study programmes			
College	13	-	-
University	56	18	9
Number of students enrolled			
College	915	-	-
University	3416	329	403

There are in total 5063 students currently studying in these 96 ITT study programmes that will provide qualification either in teaching or in social pedagogy. 2472 students study in Lithuanian University of Educational Sciences. This university, currently located in Vilnius, will be integrated with another university in Kaunas and is not independently participating in admissions to 2018-2019 school year. The Ministry will concentrate ITT training in Vilnius, Kaunas and Šiauliai in order to strengthen and consolidate teacher training.

Up until now any HEI was permitted to introduce a new ITT programme if the programme was accredited by the Centre for Quality Assessment in Higher Education. However, the accreditation process is currently being changed and will most likely shift towards field-level rather than single programme accreditation. The Ministry of Education and Science controls the student intake by determining the number of publicly funded "student baskets" annually. There will be 195 university and 120 college publicly funded ITT places available for the 2018-2019 intake. In addition to requirements for a certain admission score, pupils wishing to enrol in an ITT programme must take a motivational test.

Employment and career development

The employment of teachers in public sector schools is decentralized, leaving local authorities and schools responsible for employing individual teachers. Each municipality determines and plans its annual educational budget needs and the budget is allocated quarterly. In addition to official legal requirements for the composition of the school staff, each school principal is responsible for the size of the school workforce. It is for the principal to decide on how many teachers she or he will need each school year to accommodate the needs of the pupils. Therefore, the allocation of teaching hours is allocated per teacher per school.

New official regulations on teacher training were introduced by the Ministry of Education on Science on the 29th June, 2018. The new regulations set out profession-related competences, general rules on teacher training implementation, induction period, professional teacher development and criteria on ITT centre activity. An official induction period was for the first time introduced as a legal framework for teacher development. The induction period is one year long, and it covers the first year at school. Three partners take part in the induction period: newly employed teachers, schools, and teacher training institutions that together set out goals and objectives for the one-year long period. During the induction period constant consultation on didactics and profession-related challenges is provided by a mentor and other staff.

Continuous professional development takes part during the whole active professional life of a teacher. It starts during the induction period with more emphasis and support on the acquired competences at the teacher training centre and by developing horizontal and vertical professional career. Each teacher must further develop his professional competence by choosing a path: 1) take a subject specific teacher training course at ITT centre that would later provide an official background to become a teacher in a chosen subject 2) enrol into a full-length study programme 3) self-educate. Teachers are encouraged to enrol on a Masters degree programme at ITT centres, which are mostly shaped to accommodate the needs of teachers already in service. There are also short-term 40-hour trainings for teachers who are willing to gain knowledge in a related subject area.

Work structure

Until the recent changes in the teacher payment scheme starting in school year 2018-2019, all school staff were paid by two types of contracts that determined their pay. Subject teachers were paid by contact (classroom) and additional hours, experience and qualification category. Staff members such as management, psychologists, tutors, social pedagogues and others were subject to a full-time equivalent contract based on qualification category and experience. The official payment coefficients for other staff members are set out by the Ministry of Education and Science and vary according to total pupil numbers at the school.

Monthly teacher payment rates vary according to teaching work experience, educational degree and qualification category. The rate is set for 18 contact hours per week which is the maximum number of contact hours allowed. Rates are also set out for additional hours spent on correcting pupils' homework exercises, various teaching related preparations. These rates vary per grade (primary, lower, upper secondary) and teaching subject. Additional payment for roles such as class or group tutor can be received.

Retirement system

The retirement age for teachers is the same as for the general labour market and teachers are allowed to work at school at any age. The retirement age in Lithuania is moving towards age 65 (in 2026) and increases each year by 4 months (female) and 2 months (male). In 2018 the retirement age for males was 63 years and 8 months and for females it was 62 years 4 months.

To be eligible for the retirement pay (i.e. pension) 30,5 year of official work experience (as of 1st January 2018) is required. The total work experience in years is increased each year until it reaches 35. The retirement pay consists of three parts: 1) base pay 2) premium for those with more than 30 years of

work experience 3) premium depending on previous instalments to "Sodra" (The State Social Insurance Fund). The base retirement pay is equal to €152,92 per month (1st January, 2018).

A person is eligible for an early retirement 5 years before the official retirement age if he/ she has 30 years of required work experience. If the person starts working during these 5 years he/ she will not receive the early-retirement pay. The early-retirement pay is calculated in the same way as retirement pay. However, it is 0.4 percent lower per each month until the individual reaches the official retirement age. If, for example, a person has 5 full years (60 months) before retirement age, then his early-retirement pay is 60*0.4 percent = 24 percent lower than his retirement pay each month. Those who opt for an early-retirement pay will receive a lower retirement pay (calculated by the same 0,4 percent rule). On average, early-retirement pay is equal to €175,14 per month.[12]

There is an "Optimisation fund", coordinated by the Ministry of Education and Science, for teachers working at public schools. The fund allocates a budget for a one-time payment to encourage teachers to retire. The school or a respective municipality must apply and justify the need for the funds (based on argumentation whether this change in teaching workforce will change the average contact hours per teacher, teacher-pupil ratio, etc). Only those who fulfil retirement pay requirements can receive the one-time lump-sum payment. The size of the payment depends on the teacher's work experience in the exact school from which the teacher wants to retire. The minimum available pay is 2 average monthly salaries if work experience is lower than 36 months. The maximum available pay is 6 average monthly salaries if work experience is higher than 240 months (in the same school). This opportunity has been open for the last three years, the number of teachers that received the pay is: 666 (2015), 598 (2016) and 618 (2017).

[12] Information from the State Social Insurance Fund Board under the Ministry of Social Security and Labor "Sodra", www.sodra.lt

2 MODEL METHODOLOGY

In this section the model framework is presented. Secondly, the project design is described and anticipated project results are listed. The section also includes information on the implementation team and on funding. The scope of the model and core technicalities such as a list of specialisations and baseline statistics are given. More methodological details can be found in Annex A2.

2.1. PROJECT DESIGN

In the light of the challenges facing the teacher profession in Lithuania, described earlier in this section, this project was designed to address the lack of information on the future needs of teachers. Such information is crucial for decision-making related to ITT admissions and to many other fields such as the teacher payment scheme, changes in curriculum and other such issues.

In the following section, the main elements of the project design such as goals, research questions, outputs, team and funding are given.

AIMS AND OBJECTIVES

The aim of this project is to contribute to the balancing of the number of students enrolled in initial teacher training programmes and the actual need for teachers at schools in Lithuania.

The objective of this project is to create an analytical model providing forecasts on teacher demand. Another objective is to use the model outputs and forecasts to provide policy recommendations that contribute to answering two questions: how many teachers do we need at schools? How many students should we admit to ITT programmes?

ANTICIPATED RESULTS

There are two project outputs:

1. Short-term (1 year) and mid-term (4 year) forecasts on new teacher demand.

2. Recommendations on student admission to ITT programmes and other recommendations related to balancing the oversupply and shortage in the teacher workforce.[13]

IMPLEMENTATION

The model was created on the basis of the MOSTA project "The Implementation of Skilled Labor Supply Analysis and Monitoring System" funded by the European Social Fund. Technical assistance was provided by the Structural Reform Support Service (SRSS), European Commission. Team members:

Ana Stankaitienė (project team, Office of the Government of the Republic of Lithuania)

Beatričė Leiputė (project team, Policy Analysts, MOSTA)

Giedrius Padvilikis (project team, Policy Analyst, MOSTA)

Vilma Bačkiūtė (project team, Ministry of Education and Science)

Audronė Razmantienė (project team, Ministry of Education and Science)

Patricia Pérez-Gómez (project coordinator, Secretariat General European Commission)

Áine Hyland (project expert, Emeritus Professor of Education, University College Cork, Ireland)

[13] Due to the ITT centre reorganization and teacher training reforms that were introduced during the pilot project implementation, the recommendations on student admission were not prepared. It is seen as a long-term system output that should be produced in the future developments of the model.

Thomas Lockhart (project expert, Department for Education, England, Teacher Supply Model group)

ACTIVITIES

Various activities relating to each of the objectives were initiated and implemented during the project timeline. Several workshops, consultations and a dissemination event were organised. Slides, reports and other documents produced during the project implementation can be found on the MOSTA website and on the EC portal.

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Figure 9. Major project design elements

Aim	To improve the balance between the number of students enrolled into initial teacher training programmes and the actual need for teachers at schools in Lithuania.
Outputs	1. Short-term (1 year) and mid-term (4 year) forecasts on new teacher demand. 2. Recommendations on student admission to ITT programmes and other recommendations related to balancing the oversupply and shortage in the teacher workforce.
Implementation	• Model creation - MOSTA project "The Implementation of Skilled Labor Supply Analysis and Monitoring System", European Social Fund. • Technical assistance - Structural Reform Support Service (SRSS), European Commission.

2.2. FORECASTING AND PLANNING SYSTEM

In this further section, the forecasting and planning system is presented. Elements such as criteria for model selection and development, system stakeholders and proposed annual cycle are described. We note that by "system" we mean all the annual processes that should be involved in planning practice such as: data collection, model development, result preparation, consultations, recommendations. By using the term "model" we refer to the major element of the planning system – a quantitative model used to forecast teacher needs.

FORECASTING MODEL CRITERIA

During the early stage of the project, the project team determined the criteria for the forecasting model (Figure 10). These criteria played a key role during the model selection, creation and development phases. The model uses administrative data collected from the national registers on teachers, students and pupils. The output of the model, together with an expert evaluation or other qualitative analysis, provides annual information for policy making. Furthermore, the model must be flexible enough to allow for scenario testing options for analytics. Lastly, the model must be detailed and provide results which will enable relevant policy decisions to be taken.

Figure 10. Criteria selected for the forecasting model selection, creation and development

Data driven	Model uses data from the register of teachers and tax authorities as an input and provides quantitative projections or forecasts.
Flexible	The model allows analytics test scenarios by changing model inputs.
Automated	The model is updated annually and requires as little human-driven data mining as possible.
Relevant	The model allows flexible inputs that reflect changes in teacher training system and in general education.
Applicable	Model results are used to provide recommendations for changes in policy.
Open	The framework, input/output indicators and modelling steps are open and transparent to a wider society.
Detailed	The model results are provided by agreed level of detail.

SYSTEM STAKEHOLDERS

Stakeholders are an integral part of the teacher need forecasting and planning system. A proposed stakeholder scheme is given below (Figure 11).

Primary data holders – several data registers on teacher, pupil and student population, administered by the Centre of Information Technologies in Education are a vital part of the system. In order to collect up-to-date data and ensure its correct use and interpretation, continuous cooperation with the representatives from the registers is needed. Mutual cooperation and exchange of information regarding data structure, possible outliers or errors are essential to ensure the quality of the forecasts.

It is foreseen that in future years, model input indicators could be collected and stored in an Education Management Information System which already covers information on teachers, pupils and students. During this first pilot project, separate datasets from individual registers were collected. An automated input data renewal and indicator calculation in an already existing database (for example, EMIS) would shorten the time needed to renew the model annually.

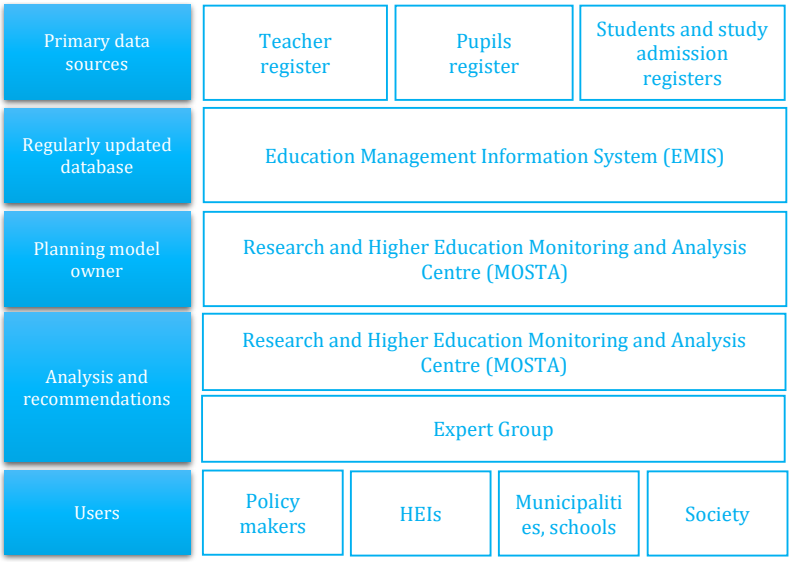
The owner and initial creator of the model is MOSTA whose analysts have the capacity to annually renew data inputs, calculations and forecasts needed. In addition, MOSTA is responsible for further model advancements and developments. To agree on the assumptions, policy reforms and other methodological elements to be changed or added annually, an expert group would play a crucial role. It is recommended that if the forecasting system is to be continued and developed further, an external group representing different players in the system is vital. To shape an integral, relevant and continuous teacher forecasting and planning system, the group should have advisory status throughout the annual process and advise MOSTA analytics on the model renewal, recommendation preparation and result dissemination. It is recommended that the group would meet once or twice a year and would also be reachable via electronic means on demand.

The group should be set up and coordinated by the Ministry of Education and Science. Many representatives from different institutions have taken part in various project activities such as workshops, consultations and other events. The proposed composition of this external work group is as follows:

- Representatives from Initial teacher training centre network
- Local authority representatives (e.g. Association of Local Authorities in Lithuania)
- Education trade union representatives
- Labour market, forecasting experts
- MOSTA analytics

Users of the system play an important role in the system development and application. First of all, the system output or forecasts will be used to form recommendations for changes or developments in current policies related to student admission to ITT, to the teaching profession etc. Higher education institutions, primarily those providing initial teacher training, will receive information that will provide a background in determining future trends, teaching workforce status and labor market prospects to enable them to prepare new study programmes and update existing ones. Local authorities and schools will receive information on projected pupil population development, on teacher needs and other indicators in the respective municipalities. Society, as a user of the system results, will be able to get acquainted with up-to-date information on teacher supply and demand in terms of shortage or oversupply in specific areas. This will provide useful information for graduates of secondary schools thinking about teaching as a study choice.

Figure 11. Teacher need forecasting and planning system stakeholders



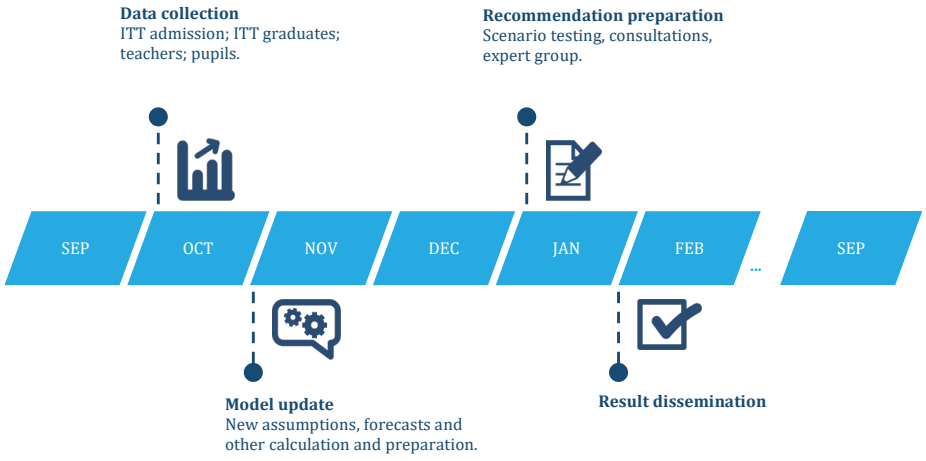
PROPOSED ANNUAL SYSTEM CYCLE

An annual "system working cycle" is proposed for implementation each year. As the school-year starts in September and time is needed for the registers to collect data on new pupils, teachers and students, it is suggested that model-related data collection could be started in October at the earliest. Since there is a risk that primary data in the registers may still be updated later on in the school year, this raises the question of how many times the primary data sources should be updated in the model. This phase also includes the collection of data on recent graduates who successfully completed a teaching qualification and would be available to start teaching.

The period between October and January would be dedicated to updating the model with new data, to considering new assumptions and to reviewing previously used assumptions, as well as any other additional calculations and changes needed. This would also include the work of the external expert group. The period between January and February would be dedicated to preparing recommendations and scenarios. Result dissemination would start as early as February – March. The period between results dissemination and new input data collection could be dedicated to methodological model developments such as revision of the calculation of input indicators, weightings used and other aspects.

The main risk related to this proposed annual cycle is whether the time window dedicated for the input data, model update and results preparation would reflect the real amount of time needed for these processes to be implemented. The schedule with which this system cycle must be synchronised is the admissions to HE system cycle. The first steps in determining the annual budget dedicated to respective year admissions are taken in December – January annually. "Student basket" distribution per study group (National Classification on Study Fields) is defined each year in February – March. Therefore, recommendations on the students who need to be admitted to ITT programmes in order to match the need in schools must come before that date. After one full round of implementation, this proposed annual system cycle can and should be improved in line with admission processes described above.

Figure 12. Proposed annual system working cycle



2.3. MODELING FRAMEWORK, SCOPE AND SPECIALISATION LIST

Model scope

First of all, we will set out the scope of the teacher forecasting model, which takes into account teaching subjects, staff types and sector, and other aspects. The model includes pre-school, general and vocational education teachers and pedagogical staff members. It uses different levels of data (individual/ class - school type – municipality) but can vary by modelling element (e.g. student supply also includes study programme, cycle, type and other). This approach addresses the issue of differences that can occur across different levels, for example differences in contact hours in rural or urban schools, class mergers, drop-outs and other factors.

The table below provides information on the coverage of the model. The results and recommendations provided will relate to public and private schools (aggregated). Individual and school level data will be used for intermediate calculations only. Separate and more detailed projections for teachers working by hours is provided separately from other pedagogical staff. In conclusion, short-term 1-year long as well as mid-term 4-year long projections are provided.

Table 2. The scope of the teacher workforce forecasting model

Aspect	Within the scope	Outside the scope
Institution type by sector	Public and private schools	-
Institution type by educational level	▪ Pre-school institutions ▪ General education institutions ▪ Vocational education schools (general education subjects only)	▪ Teachers teaching profession related subjects at vocational schools ▪ Higher education institutions ▪ Non-formal education providers
Level of detail	Municipality, national level (depending on the model element)	Individual school level (used for calculations only)
Staff type	Teachers and other pedagogical staff according to the specialisation list (Table 3)	▪ Non-pedagogical staff ▪ Specialisations outside the list (Table 3)
Forecast length	▪ 1-year short-term forecast ▪ 4-year mid-term forecast	Forecasts longer than 4-year timespan

A list of 23 specializations by type of school, level of education, post type and teaching subject was made (Table 3). In total 83% of teachers and pedagogical staff employed during the school year 2017-2018 are represented in the model. A number of post types and/ or teaching subjects are outside the scope of model scope due to their specificity. These can be incorporated during the next updates of the model.

Table 3. Specialisations within and outside the modelling scope

Specialisation	Primer unit of measurement	Weighted unique number of individuals, 2017-2018
Pre-school tutor	FTE	10744
Speech therapist	FTE	1133
Pre-primary (grade 0) class teacher	FTE	1920
Psychologist	FTE	580
Social pedagogue (educator)	FTE	1102
Teacher for children with special needs	FTE	665
Biology teacher	teaching hours	683
Chemistry teacher	teaching hours	536
Art teacher	teaching hours	790
Religion education or Ethics teacher	teaching hours	1368
Economics teacher	teaching hours	340
Physics teacher	teaching hours	657
Nature and Human Being teacher	teaching hours	339
Geography teacher	teaching hours	703
Native language (other than Lithuanian) teacher	teaching hours	252
History teacher	teaching hours	975
IT teacher	teaching hours	908
Physical education teacher	teaching hours	1756
Lithuanian language teacher	teaching hours	2861
Mathematics teacher	teaching hours	2083
Music teacher	teaching hours	1704
Optional subject teacher	teaching hours	2265
Basics of Civil Education teacher	teaching hours	342
Primary school (grade 1-4) teacher	teaching hours	5664
Subject for children with special needs teacher	teaching hours	17
Technologies teacher	teaching hours	1251
Foreign language (English) teacher	teaching hours	2982
Foreign language (other) teacher	teaching hours	1538
Human Safety teacher	teaching hours	427
Specialisation outside the model scope	**Primer unit of measurement**	
Integrated subject teacher	teaching hours	
Other art discipline teacher	teaching hours	
Non-formal education teacher	teaching hours	
Profession teacher (vocational school)	teaching hours	
Principal or other manager	FTE	
Other pedagogical staff member	FTE	
Artistic training teacher	FTE	
Assistant psychologist	FTE	
Sports coach	FTE	

Model framework

The teacher forecasting model is based on the labour demand and supply model used in determining the needs for the teaching workforce. Core model elements were described in the Section 2.1 describing theoretical sources of teacher stocks and flows. Based on that, the general model framework was designed to accommodate the specifics of the Lithuanian market for teachers (Figure 13).

In the model, teacher supply is denoted by (a) the possible inflows to the teaching pool such as the number of ITT students who are projected to successfully graduate and receive employment at schools, (b) previously non-qualified teachers entering schools via various sector engagement programmes such as "Renkuosi Mokyti"[14] or those with unknown qualification due to short time span of data used and, (c) qualified teachers who work elsewhere in the labour market and choose to enter or return to school (denoted as inactive).

The demand side has two major elements: 1. Expansion demand 2. Substitution demand. Expansion demand can be described as the total teacher numbers each year needed to accommodate changes in pupil population. Substitution describes the need to replace teachers in stock due to reasons such as death, retirement or resignation. Below we provide some methodological details on the core model elements.

It is common that subject teachers actually teach several different subjects. This means that while describing teaching stock per specialisation a challenge relating to teacher attribution occurs. Therefore, a "weighted unique" indicator was estimated. This is estimated by giving everyone a weighting based on the number of different subjects a respective teacher teaches. For example, for someone who teaches Mathematics and Informatics as different subjects, a weighting of 0.5 in each specialisation is given. A total number of weighted unique teachers is the sum of the weightings per specialisation.

Main model equation (phase 1)

The new teacher need (shortage or surplus) is equal to the total teacher demand (*ED*) due to the expansion and substitution (*SUB*) minus the teachers forecast to be supplied by the ITT graduates (*STS*), non-qualified (*NQ*) or inactive (*INAC*) by municipality *m,* specialisation *s* and year of forecast *t.* As noted before, detailed model methodology can be found in Annex A2.

$$Y_{ts} = \sum_{m} ED_{mst} + SUB_{st} - STS_{st} - NQ_{st} \ - INAC_{st},$$

How is the forecast on pupil population calculated?

The number of classes per grade, per school type (urban/ rural) and per municipality is the core indicator across the pupil forecast calculation process. The indicator is firstly constructed with the historical data. The pupil forecast denoted by the number of classes is a moving weighted average of previous 5 years multiplied by either zero-grade (pre-primary year) or retention coefficient. More weight is given to more recent data in order to emphasize the accuracy and improved data collection processes in recent years. Weights from 1-5 are attributed to historical data from 5 recent school years respectively. Different averaging and weighting methods were used during the methodology development process.

The zero-grade coefficient is determined as the share of permanent residents of a respective age that enter zero-grade. It is used to calculate how many compulsory zero-classes will be there in the future. Historical Statistics Lithuania data on the permanent resident numbers by age is used to derive the coefficient. A weighted moving average is then used to determine future coefficients.

[14] "Renkuosi Mokyti", first started in 2008, is a programme that intends to attract professionals and individuals of different sectors to schools. Renkuosi Mokyti is a member of Teach for All network.

The retention coefficient is used to calculate the changes in class number when graduating from one grade to another. It is true that, for example, not all grade 6 pupils continue studying at grade 7 due to various reasons such as changing schools, municipalities and other. Therefore, this coefficient allows us to determine the historical changes in class number per grade and to use it to forecast it further in time.

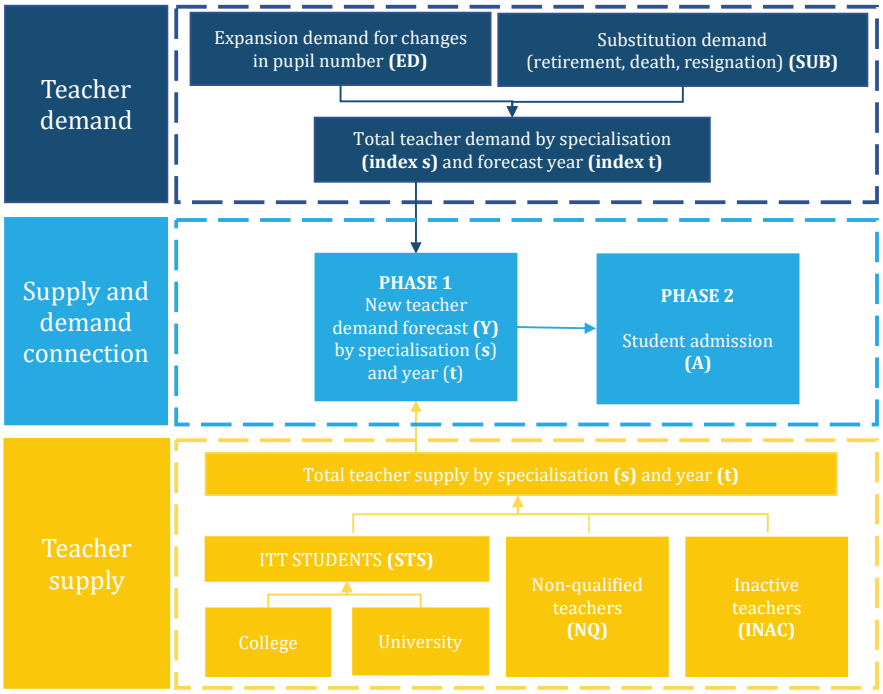
Simplified procedure is used to forecast pupils with special needs and pupils in preschool education. The main indicator used is the pupil number, forecast using the historical pupil number and forecast children of a respective age.

How is the forecast of student supply calculated?

ITT graduates are the main theoretical source for the annual teacher stock inflow. It is important to note that a small share of the students start working at schools during their study programme and are not considered as a future supply in this model since they are already active in the field and are members of the teaching stock.

To calculate the number of students entering schools each year, the model, first of all, uses the number of enrolled students (as of 2017/18) in the system who are pursuing their degree in teaching. Using the information of the respective study programme length and type, a graduation year is forecast for each student currently enrolled to any study programme. Based on the study programme, students are then matched to the model specialisation given in Table 3. Where a student is enrolled in a programme which offers credentials for several teaching subjects (i.e. model specialisations), appropriate weightings are attributed to such student.

Figure 13. Teacher demand forecasting model general framework



Furthermore, it is important to consider that not all students graduate (acquire a qualification in teaching or related field) and not all graduates seek and receive employment at school (due to various reasons that are not being examined in the model). To provide a realistic estimate of future graduates entering schools we need to look into historical data from 2010-2016 and estimate the most likely share of students who will graduate and enter schools. By using the historical data on student graduation and employment at schools, we estimate a coefficient per specialisation per study type and form, that denotes the share of students enrolled in a 1st year course of an ITT programme who later successfully graduate and start working as teachers after their graduation. By multiplying estimated coefficients by the number of students in a respective study programme, we estimate the number of students who will most likely start working in schools by 2022. It is assumed that there will be no new admissions so that only students who are studying at the time of the analysis are considered.

2.4. BASELINE 2017–2018 SCHOOL YEAR

To better understand the model scope and current situation, we provide a short overview of teacher and staff numbers and average contact hours, mostly focusing on the school year 2017-2018, for which latest data is available.

Total teacher and other school staff number

The total school staff numbers, including teachers, managers and other post-holders, working at pre-schools, general and vocational education schools are gradually decreasing and reached 55,875 in the school year 2017-2018. A small number of individuals (5339) work at various non-formal education institutions that are outside the model scope due to its specifics. The project team believes that a slightly different model accommodating sectoral details should be developed in case there is a need to forecast the educational workers within the non-formal sector. In addition, the number of non-formal sector workers only reflects institutions and organisations that are part in the funding system i.e. those non-formal activities which are funded via "pupil baskets".

Therefore, as described above, the model takes into account staff working at pre-school, general and vocational institutions. As already mentioned, several specialisations reflecting staff type or teaching subject are not considered in the model due to the same reasons as the non-formal sector. If we look at the total 55,875 individuals, 7% of teachers and staff members working in schools, have already reached retirement age or older.

In total, 84% of teachers and staff members working in pre-schools, general or vocational education schools in the school year 2017-2018 are represented in the model. 9290 individuals (16% of total) as measured by a weighted unique indicator are not represented because their posts or teaching subjects are outside the forecasting model scope. 35% of individuals represent staff such as social pedagogue, psychologists and others, 65% of individuals are teachers (Figure 15).

"Weighted unique" numbers per specialisation (explained above) are given in Table 3. As can be seen, there are approximately 10744 pre-school tutors which is the largest group represented in the model. The second largest group of 5664 is the primary school (school year 1-4) teachers. Other large groups are teachers of foreign language (English), Lithuanian and Mathematics. Other groups such as Human Safety (427), Economics (340), Nature and Human Being (339) are rather small as measured by the "weighted unique" formula, because most of the times these subjects are being taught by teachers who teach another core subject at school. In addition, the qualification requirements for Human Safety, Economics and other similar subjects are not as strict and allow teachers to teach these subjects in addition to their main subject (i.e. the subject which takes most of their time). The smallest group is the group of teachers for children with special needs (17). The size of this group can be mostly explained by the fact that children with special needs are often part of regular classes and are taught by teachers who do not specialise in special needs or also are taught by subject-specific teachers.

Figure 14. Number of teachers and staff members in Lithuania by school type and school year

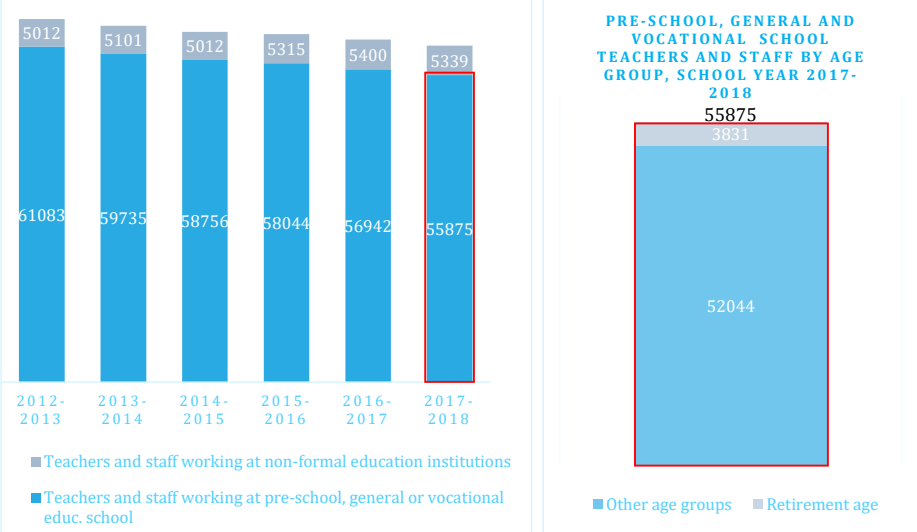
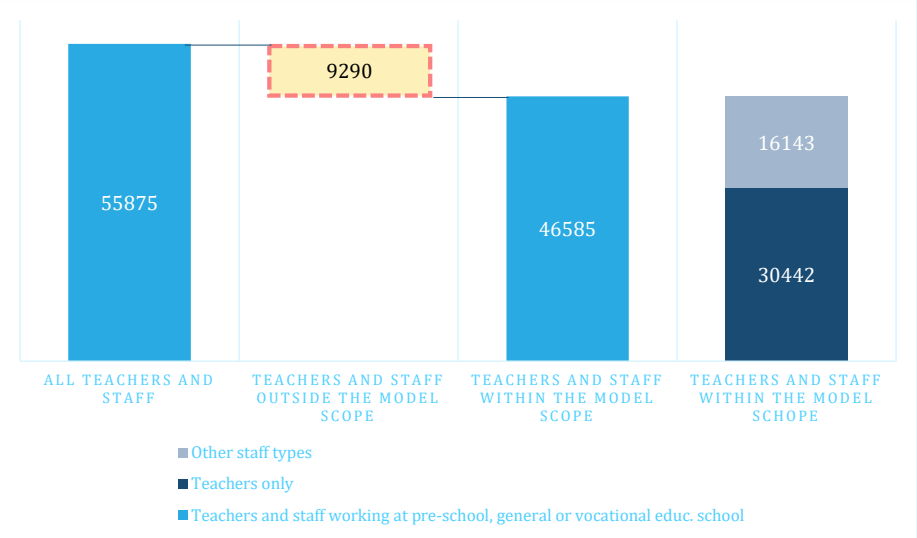


Figure 15. Weighted unique of teacher and staff members within the model scope 2017-2018



Average number of contact hours

The average number of contact hours per teacher differs depending on teacher age, school location and specialisation. On average teachers who are employed and paid hourly work 18 hours. Teachers who are under 30 years of age work on average 16,7 hours. As of 2017-2018, there were 133 teachers older than 71 years of age, who on average have only 11,4 contact hours per week. Overall, the contact hour number per person is lower at the beginning of the teaching career, goes up until age 40 and is stable until the age of 60 when it then goes down again (Figure 15). The spikes in the age-hour profile are due to a low number of individuals in a sample per specific age. The age group 46-60 is the largest age group with 17147 teachers.

On average, teachers in schools located in cities work more hours than teachers in village schools. The largest difference can be seen in the youngest age group below 30 where teachers in villages schools teach 1,7 weekly hours fewer than teachers in city schools. As for age groups 31-45 and 46-60 the difference is 0,8-0,9 weekly hours. The only age group where teachers in village schools (11,9) work on average slightly more than city (11,3) is the group over the age of 71. However, this group is very small (Figure 16). This overall difference in contact hours might be explained by a lower total number of classes in village schools where it might become a struggle to provide teachers with a sufficient number of hours, bearing in mind the existing payment scheme.

When looking at different specialisations, teachers of History, Mathematics and Biology have the highest number of average contact hours (Figure 18). Teachers in IT, Physics, Art and others have fewer than 20 weekly hours which, without experience at school and qualification category, leaves them with lower financial reward. As mentioned before, usually teachers in Economics, Human Safety and other such subjects teach core subjects in addition to these subjects, due to flexible qualification requirements. This explains the very low average number of contact hours for some of these subjects.

Figure 16. Average contact hours by teacher age group and school location type, school year 2017-2018

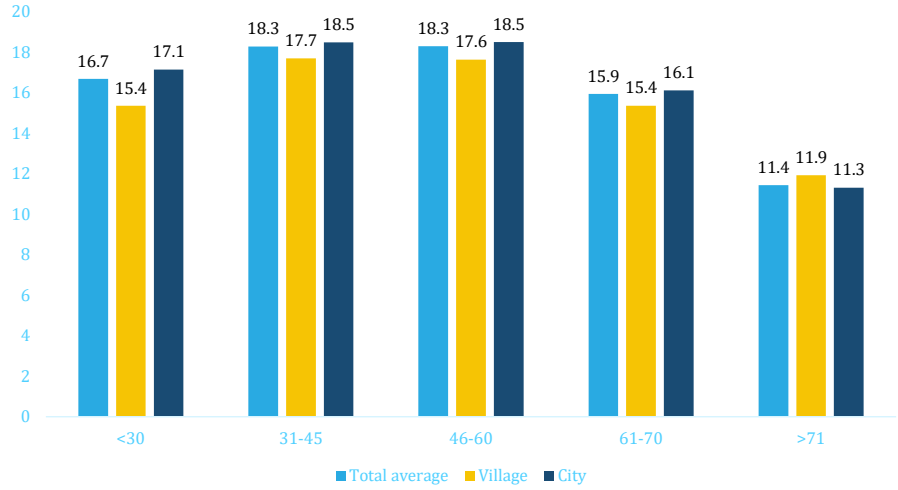


Figure 17. Average number of contact hours by teacher age, school year 2017-2018

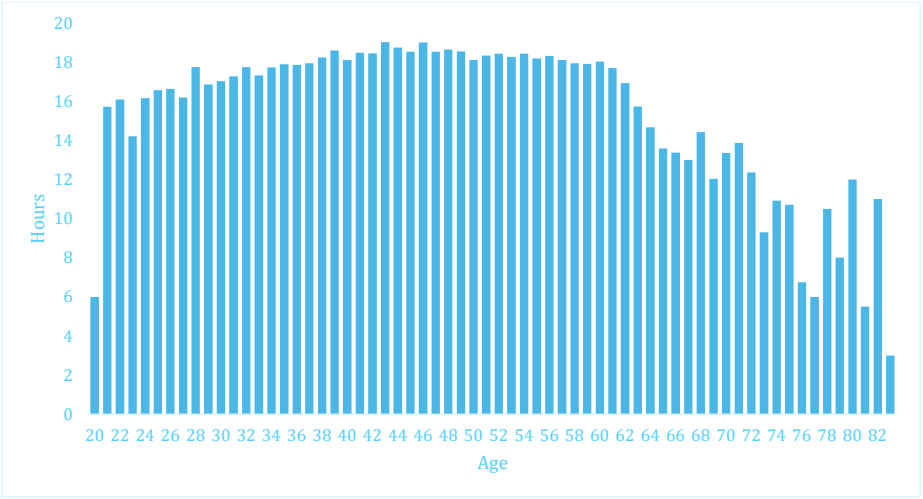
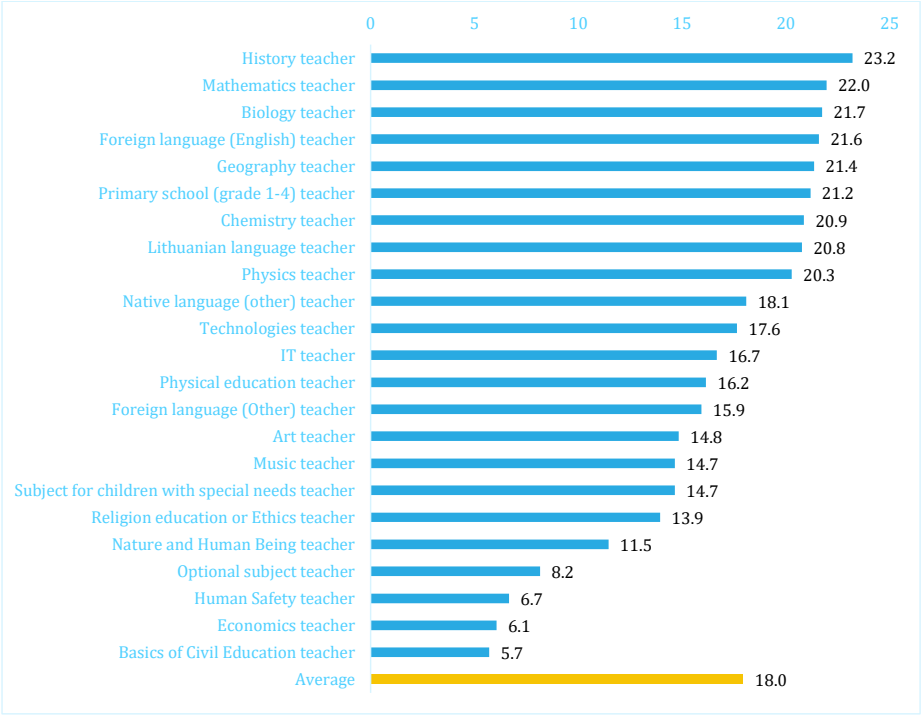


Figure 18. Average number of contact hours by specialisation, school year 2017-2018



3 MODEL ASSUMPTIONS

Modelling assumptions hugely determine the final results of teacher need, therefore, must be explained in detail to better understand the final results. Below, selected core assumptions and figures on forecast pupil number, ITT graduates entering schools and teachers leaving schools are given.

3.1. PUPIL POPULATION FORECAST

Pupil forecast is the main element that drives the expansion demand, indicating whether the sector is about to shrink, stay the same or expand due to changes in the number of children who need to be educated in schools. Forecasting pupils is more straightforward than other model elements since children who will start school in 2, 3 or more years are already born. As we mention in the literature overview given later in the report, there are several ways to estimate the size of future pupil population. We choose to estimate the class number as the main indicator to determine the future pupils' needs. Furthermore, it is important to mention that estimates provided are subjected to scenario testing, therefore the results provided below can be considered as a baseline scenario.

We will start by looking at changes in the number of permanent residents in Lithuania that highly determines the size of cohorts that start school every year. While looking at the changes in permanent resident number, we can see obvious differences in age groups (Figure 1**Error! Reference source not found.**). There was a decline of 13% in the age group of 6-11 from 2010 up until 2014, after that it increased by 3% until 2017 and is forecast to grow but it will most likely not reach the 2010 figures. The age group 0-5 has remained stable over time with an average annual change of 0.4%. It is forecast that the number of permanent residents aged 0-5 will grow by 2% in 4 years' time. The age group 12-18 had a sharp fall in numbers since 2010, the number of permanent residents has decreased by 32 percent by 2017. It is forecast that the number of residents in the respective age group will keep on decreasing in 2018-2020 and shrink by 8% in 4 years-time. These trends significantly impact the forecast pupil population that further determine the need for staff in schools, students to be trained and other central educational system participants.

Based on the official statistics[15], 7178 children aged 0-18 emigrated from Lithuania in 2017. As compared to 2010, this number has significantly decreased by 35% (11105 individuals). The average annual decrease in the age groups 0-5 and 6-11 was approximately -4% and -5% for children aged 12-18. If we account for changes in permanent resident number, emigration of children aged 0-18 decreased from 1,7% of total residents of a respective age group (2010) to 1,3% (2017). Based on the historical tendencies, there is no reason to believe that child emigration will significantly increase in the following mid-term. In terms of modelling, pupil movements to and from the country are reflected via retention coefficients, which describe the change in number of classes while progressing from one grade to another.

It is important to note that by using retention coefficients it is not possible to determine which grades shrink due to emigration and which due to domestic migration. While some of the grades shrink in total number of classes, others increase, indicating redistribution of pupils between municipalities within the country. Looking closer we can see that average retention rate is lower across all the grades in schools located in a village type of settlements (Table 4). This is expected since pupils tend to move from one school to another due to the way school network is organised, also for reasons of self-interest such as better schooling and others. This explains why, starting with grade 6, the class retention rate in city schools is over 100% - pupils from village and other surrounding schools move to study in the cities where more schooling opportunities are available. As such, the retention coefficient helps to explain and estimate a realistic class number within and between municipalities.

[15] Emigration by age, Statistics Lithuania, Official Statistics Portal, 2018

Figure 19. Forecast on the number of permanent residents in Lithuania by age group

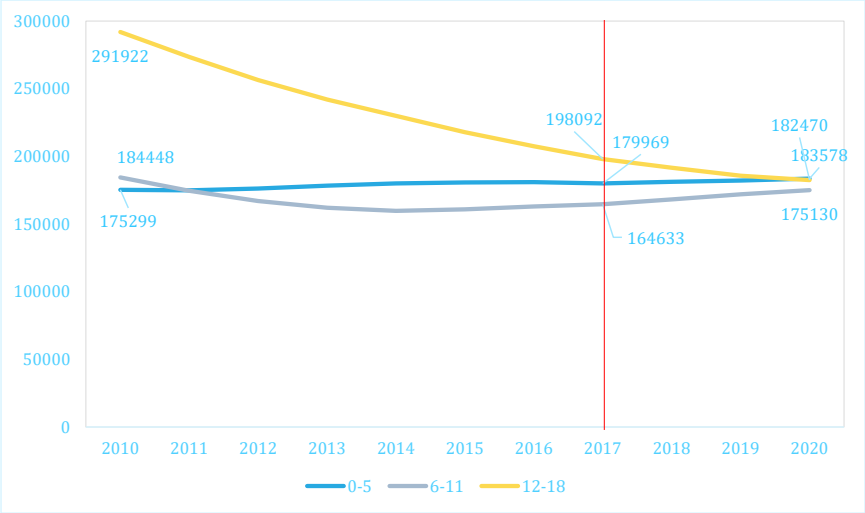
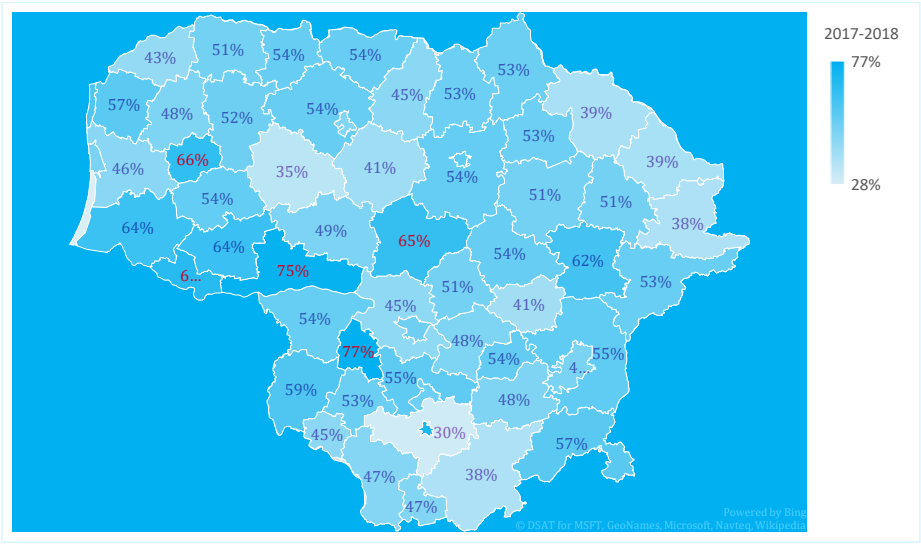


Table 4. Average class retention rate by grade and school type, 2017-2018

	1	2	3	4	5	6	7	8	9	10	11	12
Village	73%	80%	81%	82%	70%	80%	79%	80%	80%	78%	36%	77%
City	84%	98%	99%	99%	83%	102%	103%	101%	117%	101%	102%	99%

Attending pre-primary school year (grade 0) is compulsory for all children since the 1st September 2016. Primary education is compulsory for all 7-year-olds, therefore mainly children at the age of 6 and only a small share of 5-year-olds start grade 0. We use a coefficient to estimate the share of children aged 5-6 who attend grade 0 and use it to forecast the class number at grade 0 in each municipality. On average 55% of children aged 5-6 attended grade 0 in their municipality of residence in school year 2016-2017 and 51% in 2017-2018. This share varies across municipalities of Lithuania with a minimum of 28% in Neringa municipality and maximum of 77% in Kazlų Rūda. This estimate also reflects the mobility of residents, it is very likely that residents of Neringa tend to have their children attending schools in larger municipalities with more schooling opportunities or municipalities where parents tend to work. Therefore, the coefficient does not indicate the education participation rate as such and the aim of this estimate is to reflect the share of pupils that will attend school in a respective municipality.

Figure 20. The share of 5-6 year old children (registered as residents of a respective municipality) of the total number of pupils attending pre-primary education in a respective municipality, 2017-2018.



Based on the projected number of children in Lithuania, grade 0 take up, class retention rate and other indicators described above, it is forecast that in 4 years' time, the total number of classes might increase and reach 20204 in 2021-2022 (Table 5). The historical decrease in total class numbers in Lithuania slowed down to -2%. It is forecast that with the capacity of new incoming cohorts the total class number could increase by, on average, 2%. In total, the four-year increase as compared to the baseline year 2017-2018 could reach up to 7%.

While looking at different groups of pupils, we can see that the increase in total class number will be mostly driven by pupils attending grades 4-7 with a total 4-year growth of 11-13% (Table 6). Larger cohorts that are currently studying at pre-primary and primary education will start entering lower secondary education and therefore show increases in total class number. Growth of 5% and lower is foreseen for grades 9-11 representing older cohorts of pupils and a negative growth with a total of 5% decrease in class number is forecast for grade 12.

If we look at the forecast class number, the expected 4-year change varies between municipalities (Figure 21**Error! Reference source not found.**). It is forecast that the lowest change of a 2% decrease in class number is expected in Vilnius district and Marijampolė municipality. In total 4 municipalities will face a decrease in class number, whereas for other 56 the total class number will either remain stable or increase. There are 16 municipalities where the 4-year growth in class number is 15% or higher.

To determine the total pupil numbers, estimates for pupils per class are needed. Historically, pupil number per class varies between grades and school types. It is therefore a subject for an assumption or a goal to reach.

Table 5. Total class number by school year

2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
24007	23278	22131	20870	20174	19773	19230	18809	19097	19456	19791	20204

Figure 21. Percentage change in the total class number by municipality, 2021-2022 compared to 2017-2018

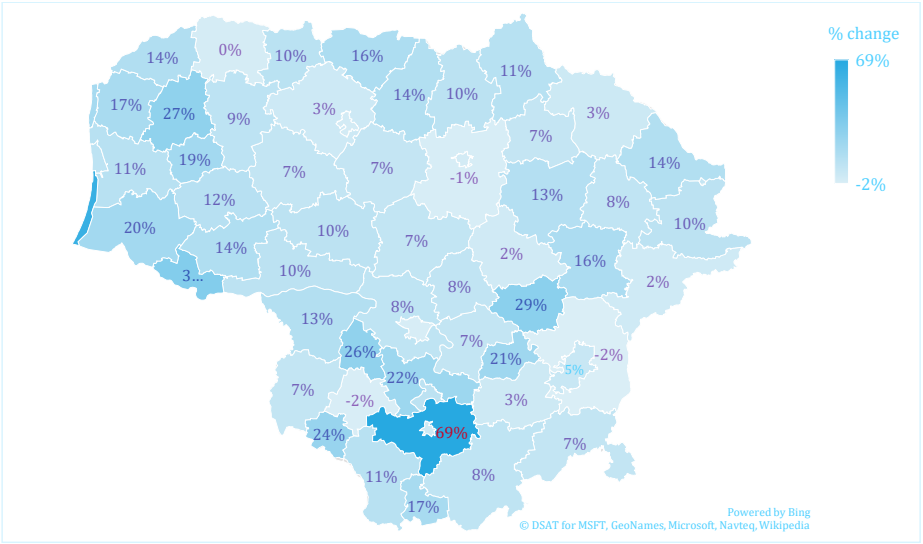


Table 6. Forecast class or pupil number by grade.

	2017-2018**	2018-2019	2019-2020	2020-2021	2021-2022	% change 2017-2022
Pre-school*	*97,2*	*97,8*	*98,3*	*99,1*	*99,3*	*2%*
Special needs*	*19,6*	*19,4*	*19,4*	*19,5*	*19,5*	*-1%*
0	2001	2110	2123	2126	2189	*9%*
1	1643	1680	1756	1764	1768	*8%*
2	1633	1640	1674	1748	1758	*8%*
3	1602	1636	1644	1676	1747	*9%*
4	1505	1601	1635	1644	1675	*11%*
5	1274	1312	1396	1428	1433	*12%*
6	1292	1282	1321	1407	1437	*11%*
7	1264	1308	1302	1340	1430	*13%*
8	1277	1276	1320	1316	1354	*6%*
9	1346	1369	1374	1420	1419	*5%*
10	1327	1304	1333	1340	1384	*4%*
11	1275	1288	1276	1291	1304	*2%*
12	1370	1291	1302	1291	1306	*-5%*

**Forecast for pre-school and special needs is given in pupil number.*

***Data from school year 2017-2018 represents figures from national registers and is used as a baseline for a percentage change in pupil/class number calculation given in Column 7. Figures in Columns 3-6 represent estimated forecasts.*

3.2. ITT STUDENT SUPPLY

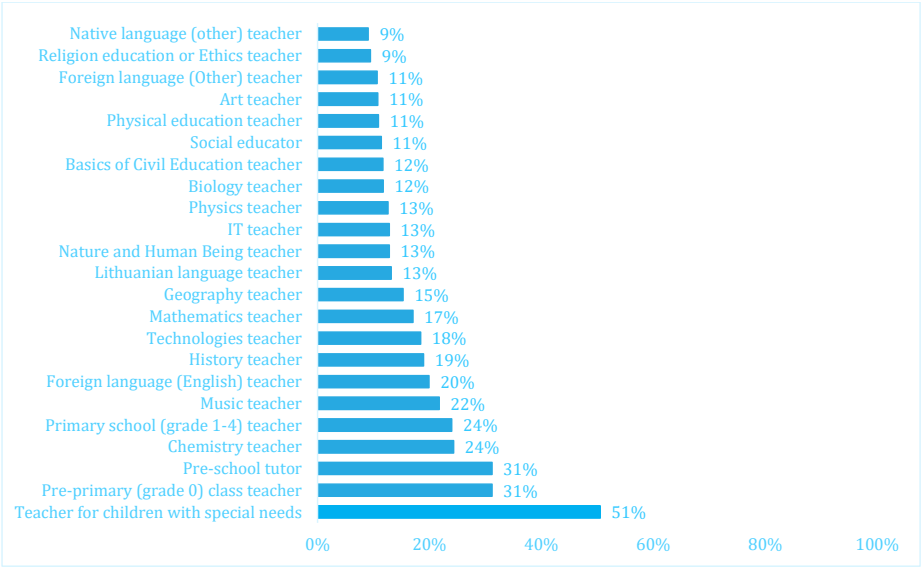
Several selection mechanisms are worth considering while analysing the main source of teacher supply i.e. students who will graduate from ITT programmes in higher education institutions. In short, the pathway towards a teaching career involves steps such as high school graduation and matura examinations, admission to ITT programmes based on admission score and motivational interview. After that, there may be drop-out of study programme due to various reasons such as low achievement rates, lack of motivation or other individual reasons. At the end of the study programme, examinations must be taken to receive a diploma in higher education. Finally, the search for a school for a job placement must be made in order to start teaching. This is the most usual pathway of someone in a concurrent Bachelor degree study. We must also consider the main mechanisms – graduation and employment - that determine the number of graduates entering schools of Lithuania in the future.

Approximately 1084 students were enrolled in different ITT programmes across the higher education system in 2017-2018. Bearing in mind the study year that students are enrolled in, and the length of the respective study programmes, we determine the total weighted number of students per specialisation who are due to graduate in the following 4 years (Table 7). This describes the capacity of higher education institutions to provide teachers with no new admissions happening. It is important to note that due to difficulties in determining exact supply source (ITT programme) a student supply forecast is developed for 23 out of 29 specialisations. The largest in number specialisation is Physical education teacher, it is expected that almost 995 students will graduate (at full capacity) in the following six years. In contrast, there are almost no students in Physics (5).

To build up the forecast, we must look at the historical student graduation and employment figures. We have constructed an indicator that looks into the share of admitted ITT students who successfully graduate (receive qualification) in the nominal time of their respective programme and get employed at schools within the model scope in the 2 following years (Figure 22). At first glance, it is evident that only a low share of admitted students graduate and start their teaching career within the allotted time. The highest indicator is seen in specialisations such as Pre-school tutor (31%), Pre-primary teacher (31%) and teacher for children with special needs (51%). Other specialisations have a much lower graduation and employment rate - of 24% and less. Other indicators with less restrictions on the timespan for graduation and employment were tested during the analysis and indicated no significant difference in the timespan chosen. It is therefore necessary to conclude that there are two evident obstacles in this stage of a teacher career: 1) graduation 2) employment. Reasons of various origins can explain these figures, starting with motivation, academic ability, financial, economic aspects and other non-pecuniary motives.

A possible reason for low graduate employment is low intrinsic motivation to teach. It is likely that students enrol in an ITT training programme to gain entry to higher education rather than to become a teacher. We can look at the statistics of motivational tests and interviews that are conducted at higher education institutions. Students willing to enrol in an ITT programme take motivational tests or interviews and might receive 0-2 additional points on top on their admission score. On average 6% of students that took the test did not pass it in the admission year 2016. It is even more interesting that out of 1574 students that signed up for the test, only 882 (56%) actually showed up. The highest share (48%) of those absent were in the HEI with most ITT programmes to offer. Even though this information does not provide a solid background to test student motivation, it provides meaningful insights for further consideration.

Figure 22. Share of 1st year ITT students that graduate in nominal length of their respective study programme and get employed at schools within the model scope in 2 years after graduation. The rate given is an average for cohorts 2010-2016.



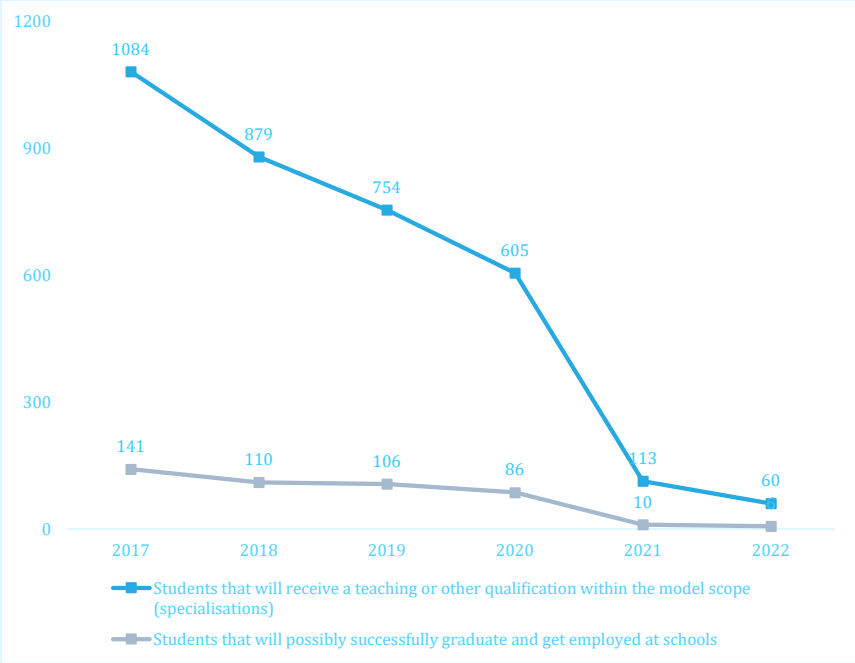
For another example, we looked at the cohort of 2015 graduates from the study field of Pedagogics (total of 1563) 6 and 18 months after graduation. Only 63% of those who started their studies in 2011 graduated in 2015, (i.e. within the nominal time period). The share of those employed at general education or at preschool level increased by only 3 percentage points while comparing 6 (36% of graduates) and 18 (39%) months. Other graduates were found to be working in the non-educational sector (37% and 35,5% respectively). Approximately half of the graduates were employed in the same municipalities as their ITT training centre. The average monthly income (bruto) for those employed in general education and preschools was approximately 581 EUR half a year after graduation and 718 EUR 18 months after. Those working in other than education sector earned on average 502 EUR (6 months) and 642 EUR (18 months). Therefore, at the beginning of their career, the average ITT graduate earnings are similar regardless of the sector of work. In later years, those working at schools earn on average more. To conclude whether the difference is significant and growing with labour experience, more detailed analysis is needed.

We use the graduation and employment coefficients introduced in Figure 22 to estimate the final (baseline) student forecast. Smaller scale coefficients are calculated per educational level, study programme, study type and institution. Students that cannot be attributed to a specific specialisation are not included. We conclude that 879 individuals (weighted unique) might be expected to graduate in 2018/19, however based on the analysis above, we forecast that only 110 will successfully graduate and get employment at school. In total, 459 are forecast to graduate and start careers in schools in 6 years time. This large difference demonstrates that ITT training centers have higher capacity and can be more efficient as a source of supply for teachers in the schools of Lithuania. However systematic changes in teaching profession stages are needed to provide means to unlock the efficiency of ITT programmes.

Table 7. Enrolled students due to graduate by expected graduation year and specialisation (weighted unique).

Specialisation	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Pre-school tutor	57	79,5	121	95	12	8
Pre-primary (grade 0) class teacher	54,5	72	110,5	95	12	8
Social pedagogue (educator)	108,5	101,5	58,5	42	17,5	0
Teacher for children with special needs	57	35	25	19	0	0
Biology teacher	22,5	15,5	10,5	1	1	0
Chemistry teacher	2,5	1	0	0	0	0
Art teacher	24,5	15	7	0	0	0
Religion education or Ethics teacher	29,5	16,5	16,5	14	3,5	0
Physics teacher	4,5	0,5	0	0	0	0
Nature and Human Being teacher	18	12	10,5	1	1	0
Geography teacher	32	18	12	1	2	0
Native language (other than Lithuanian) teacher	12	9	5	7,5	1	0
History teacher	32	27	10,5	2	0	0
IT teacher	17	7	2,5	1	0	0
Physical education teacher	262	244	199	201	54	35
Lithuanian language teacher	49	37	15,5	4	0	0
Mathematics teacher	16	2	2,5	1	0	0
Music teacher	116	76	45	34	0	0
Basics of Civil Education teacher	27,5	5	4	8	0	0
Primary school (grade 1-4) teacher	37,5	47,5	62,5	69	3	9
Technologies teacher	20,5	13	3	0	2	0
Foreign language (English) teacher	70	33,5	21,5	7,5	3	0
Foreign language (other) teacher	14	11,5	11,5	2	1	0
Total	**1084**	**879**	**754**	**605**	**113**	**60**

Figure 23. 2017/18 enrolled students that are forecast to successfully graduate and get employed at schools versus the total pool of students by expected graduation year.



3.3. TEACHER RETIREMENT

Each school year the teacher composition in schools changes due to natural turnover – teachers and school staff leave due to retirement, resignation, sometimes death or unexpected reasons. Due to age distribution of teachers in Lithuania, retirement can become a challenge for schools where the average age of teachers is high. Bearing in mind that teachers are allowed to work in schools while in retirement, it is difficult to determine the exact age at which replacement will be needed. By using historical data, we estimate a probability of retirement by age and use it to forecast "teacher-to-retire" numbers in the years ahead. More information on the retirement for teachers is given in the previous Subsection 1.2.

Based on the historical data relating to the teaching workforce, it is calculated that approximately only one-fifth of teachers retire during their first year of retirement age (Figure 24). As expected, the proportion of teachers leaving due to retirement increases with age. Approximately 20% of teachers aged 62 retired in 2012/13 - 2017/18 and 24% of those aged 65-66. The largest group (715) of teachers working while beyond retirement age in the recent school year 2017-2018 were teachers aged 63. A total of 3693 teachers 62 years of age and older were working at schools in 2017-2018. Therefore, we use this share per age coefficient to determine the actual number of teachers likely to retire in the 4-year time period.

Considering the probability of retirement and leaving school, we forecast that 3077 teachers working at schools in 2017-2018 will leave schools in the 4-year time period (Table 8). The largest specialization with the most teachers to retire are pre-school tutors working with children up until grade 0. In addition, approximately 306 primary education teachers are about to reach retirement age and leave schools in the next 4 year. This is predictable since pre-school and primary education teachers are the largest specializations in our model. Estimates for other specializations are given in the table below. We call this an element of a basic scenario, which is used to determine total teacher need. Scenarios using lower or higher teacher retirement figures (different probabilities to retire by age) will be given in the Results section of this report.

Figure 24. Teachers leaving schools due to retirement by age

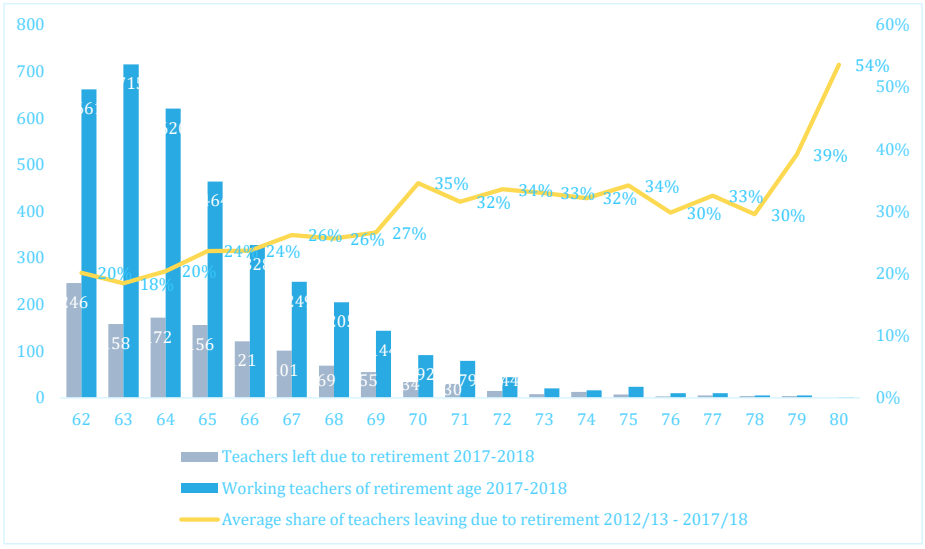


Table 8. Number of weighted unique teachers forecast to retire and leave schools by specialisation: baseline scenario

Specialisation	2018-2019	2019-2020	2020-2021	2021-2022
Pre-school tutor	187,7	189,8	164,5	138,4
Speech therapist	30,7	26,8	20,4	17,4
Pre-primary (grade 0) class teacher	29,2	30,1	24,3	23,7
Psychologist	3,0	2,8	2,4	1,5
Social pedagogue (educator)	3,7	4,2	4,0	2,3
Teacher for children with special needs	13,2	11,8	9,1	7,7
Biology teacher	13,3	14,1	10,9	9,2
Chemistry teacher	19,5	17,5	15,4	11,9
Art teacher	14,5	14,4	12,9	10,0
Religion education or Ethics teacher	22,0	22,5	18,3	15,0
Economics teacher	5,1	5,3	5,0	4,0
Physics teacher	27,1	25,7	19,6	17,2
Nature and Human Being teacher	5,9	6,0	5,7	5,6
Geography teacher	19,1	17,6	15,9	11,9
Native language (other than Lithuanian) teacher	6,9	6,3	5,5	4,9
History teacher	20,4	22,1	18,5	14,8
IT teacher	7,2	7,3	5,6	6,0
Physical education teacher	36,9	36,9	28,7	24,3
Lithuanian language teacher	43,8	48,0	39,7	36,5
Mathematics teacher	53,0	57,7	47,3	39,2
Music teacher	51,1	45,0	36,1	30,3
Optional subject teacher	41,2	42,2	36,1	31,9
Basics of Civil Education teacher	4,2	5,7	4,9	3,8
Primary school (grade 1-4) teacher	80,1	86,1	73,9	66,4
Subject for children with special needs teacher	0,1	0,1	0,0	0,0
Technologies teacher	23,4	24,5	19,5	18,2
Foreign language (English) teacher	30,0	33,6	30,5	26,4
Foreign language (other) teacher	53,5	56,1	46,4	40,8
Human Safety teacher	8,2	9,2	7,5	5,9
Total	**854**	**869**	**729**	**625**

4 THEORETICAL SOURCES AND SOME INTERNATIONAL EXAMPLES OF TEACHER FORECASTING MODELS

The issue of the future size of the teacher workforce is not unique to Lithuania and can be found across the literature on Educational Science and Education Economics. Several countries and education systems introduced models and tools that tackle the question of teacher supply and demand. Therefore, we will provide a short overview of the theoretical aspects of teacher workforce planning, exploratory analyses and models that were introduced in England and Ireland.

4.1. THEORETICAL SOURCES RELATING TO TEACHER SUPPLY AND DEMAND

The fundamentals of various teacher demand and supply modelling techniques are similar throughout the existing literature. It could be concluded that the main factors determining teacher supply and demand are agreed on. In this section, we will review the literature relating to forecasting teacher supply and the indicators by which supply and demand can be measured.

To start with, an importance of defining a "teacher" has been emphasised by Peter Williams[16]. Differences in the workforce can be seen in terms of contract type, absence due to sick, maternity or other leave, public or private sector and other. The author highlights that the more detailed the level of aggregation, the more sophisticated data and methodology is needed. More detailed forecasts can provide valuable information for policy makers, for example an overall oversupply on the national level may not indicate that there are issues on the subject level, for example, a shortage in mathematics, science and other subject teachers. In addition, compromises on what is wanted and what can be achieved have to be made.

The two main factors that drive the size of the current and future teacher stock (defined as teachers in service) are the number of pupils at schools and pupil-teacher ratio. The inflow and outflow of teachers are also relevant. According to P. Williams, the first two factors depend largely on policies that in turn are dependent on the cultural and social values of the society. In addition, funding for education and public resources define the size of pupil population and the number of teachers used to educate them. Also, the stock can represent an undesirable situation when, for example, many unqualified teachers are in service. This situation is best described by P. Santiago[17], referring to the situation as "hidden shortage" or "out-of-field" teaching.

Going deeper, the size of the pupil population depends on the start-of-schooling age and the duration of school attendance, which differ from country to country. In addition, the total number of permanent residents (and those joining it) and participation rates determine the size of each pupil cohort. Therefore, to measure the projected pupil size detailed population census and projections are required as well as educational data. With accurate data on the number of children already born, short and mid-term projections can be calculated.

The technical issues or "educational technology" influencing the number of teachers in stock can be defined as the way that education is organised including curriculum, teaching methods and other. This can be further detailed into class sizes, instruction time and teaching loads. As P. Williams emphasizes, there are several ways to quantitively approximate educational technology. The most common is pupil-teacher ratio. The second, more complex way is to measure class sizes and teaching loads. Most of the challenges quantifying educational organisation arise with physical restrictions (number of classrooms in the building) and population distribution – class sizes may be very different in rural areas where pupil population is not that dense.

[16] UNESCO (1979*), Planning teacher demand and supply*, United Nations, Paris.
[17] Santiago, P. (2002), *Teacher Demand and Supply: Improving Teaching Quality and Addressing Teacher Shortages*, *OECD Education Working Papers*, No. 1, OECD Publishing, Paris. http://dx.doi.org/10.1787/232506301033

Without going deeply into the topic, the most heated debate among educational researchers is the desirable size of a class. Official requirements relating to the number of pupils in a class determine teacher need, however, the question is whether and how various class sizes affects pupil achievement, one of the most used educational output measures. While researchers have delved deeply into the net effects of class size, mixed evidence can be found across the literature. Those supporting the positive effects of class sizes often highlight the theory that more personalized, one-on-one time increases pupil achievements. Those opposing the reduction in class sizes find that teacher quality is the main driver of pupil achievement. They also argue that national class reduction is a very costly policy to implement. The debate continues with various research on different population groups, geographical distribution and other levels of detail. As P. Santiago notices, before considering a measure to help increase pupil achievement, a comparison with other cost-efficient measures that tackle the same issue should be considered by, for example, conducting a cost-benefit analysis.

As outlined by P. Williams, the demand for teachers can be split into three major groups: development, special replacement and normal replacement demand. The first can be defined as a change in pupil numbers and educational organisation as described above. Special replacement demand refers to replacement programmes for teachers with short-term contract, unqualified teachers hired for to cover shortage and other possible cases. Normal replacement demand rises due to natural wastage. Even without special replacement schemes, teachers will still need to be substituted due to death, retirement or resignation.

Teacher inflow, or in other words, supply, can be defined as the annual addition to the teaching force. Newly recruited teachers can come from several different sources: initial training, inactive teachers-returnees (reserve pool); domestic labour market (non-qualified teachers). Initial teacher training graduates usually make up the largest share of newly recruits and is the main source for new teachers. The flow of graduates each year depends on the capacity of teacher training centres and other arrangements such as funding for the training programmes. However, teacher training systems usually suffer from a wastage of a different magnitude from country to country. With wastage rates being high, it gets more complex to determine the number of an actual need for new graduates to enter schools as teachers. As P. Williams notices, other minor channels could be national service arrangements and foreign labour markets.

There might be various reasons for a shortage in teacher stock. A very abstract one to start with is the decline in the overall interest of teaching profession mainly caused by the increased attractiveness of outside professions (opportunity cost). A proposed indicator imperfectly capturing the issue is the ratio of teacher salaries to GDP per capita over time. Deterioration in working conditions can also contribute to the overall image of teaching. However, this is very hard to measure. As proposed by P. Santiago, an indicator of "difficult to fill" vacancies is the number of unfilled vacancies over a significant period of time and implies possible shortages in teaching stocks. Increasing retirement rates and baby booms (indicating that the shortage is more on the demand side) can also represent reasons for the lack of teachers in schools.

While debating what induces individuals to opt for the teaching profession, there is strong empirical evidence of the impact of relative salaries, as summarised by P. Santiago. A common finding is that teachers with a higher salary tend to stay longer in teaching while those with higher opportunity costs quit teaching sooner. Also, the lower the relative salary, the less likely a graduate is to enter a teaching career. In addition, attrition from teaching is higher at the beginning of career. There is a lower tendency for those with longer teaching experience to quit teaching. There is some evidence that non-pecuniary factors also have an impact. For example, evidence suggests that pupil characteristics can have an impact on a teacher's decision to switch location or to quit teaching.

Another aspect addressed by the literature is how changes in the macroeconomic situation in a country impact teachers. P. Dolton et al[18] examines the effect of a business cycle on the teaching workforce. The authors introduce a theoretical teacher supply and demand model and its relation to unemployment.

[18] Peter Dolton, Andrew Tremayne, Tsung-Ping Chung, (2003), *The Economic Cycle and Teacher Supply,* OECD.

A simple model analyses how an agent (teacher) decides between leisure and work in either a teacher or non-teacher market based on relative wage and unemployment in both sectors. Theoretically, an exogenous change such as technological progress should increase the demand for labour and, therefore, wages would rise. However, this is likely to have more effect on the private than the public (i.e. teacher) sector. In the short term, this would imply lower wages for teachers and a decrease in teacher supply.

According to the literature review, there are various measures that can be taken to achieve the balance between teacher demand and supply. In addition to the obvious ways like controlling the teacher-training intake, policies related to teacher retention and loss could be introduced. Special programmes for inactive teachers, willing to return to schools, could help achieve the balance. Other policies regulating pupil-teacher ratio such as class sizes, teaching loads, contact hours and others can be adjusted. However, as P. Williams notes, the objective of balancing the teacher workforce should only be a minor, side objective of an educational planner, adding to other major goals that the system has. Other possible short-term measures indicated in the literature in times of shortage include relaxing qualification requirements and raising teaching loads (P. Santiago, 2002). Both of these measures are known to negatively affect educational quality. Bonuses could be offered to teachers of subjects which are in short supply. In the longer term, as P. Santiago highlights, other measures which could be introduced might include increases in salaries and changes in the career development system. These two areas are now being reformed in Lithuania, as was explained in Section 1.

In light of the findings of the literature review which we undertook, we conclude that there is general agreement on the major issues that affect teacher supply and demand. Common principles relating to sources of teacher inflow and directions of teacher outflow are prevalent across the literature. Therefore, the major terms and principles used in the model we present in this report coincide with the elements described in the literature review and best practice examples given in the following sections.

PREVIOUS EMPIRICAL EVIDENCE IN LITHUANIA

There has been no systematic or continuous approach to analysing teaching workforce supply in Lithuania and there is a shortage of empirical evidence relating to the field of teacher supply and demand. However, some articles and projects have been published by Lithuanian researchers on the topic over the past 20-30 years (since Independence) and their findings will be summarised in the following section. The use of the results provided below on policy making is not known.

In 2003, Dzemyda et al.[19] proposed a quantitative model to analyse and forecast the teaching workforce in Lithuania using data from the teacher database (Register of Teachers in Lithuania). They also published some further work on the topic in the following years. The model proposed reflects the main elements of teacher workforce modelling, provides a forecast on pupil number but does not look into ITT graduates at a more detailed level. Considering inflows only and not being able to discriminate between recent graduates and teachers from outside the market does not provide sufficient evidence for admission planning to ensure that the need for qualified teachers is met. Dzemyda et al finds that 97.1% of (born) children start school at age 7 and uses that to form the forecast on the future pupil population. That forecast shows a low-birth cohort entering the schools, who are now in the higher grades or entering higher education institutions. This confirms the annual decrease in the number of high-school graduates and higher education entrants that has been seen for several years now. By using pupil forecast and pupil/ teacher ratio that was assumed to be stable over time, the authors estimated teacher need. It is concluded that "the number of teachers grows at a similar rate as the number of pupils independently of the political and economic factors affected the Lithuanian state education system", which implied that without any top-down measures to accommodate the decrease in pupil population, schools would decrease their capacity themselves.

[19] G. Dzemyda et al (2003), *Forecasting Models in the State Education System*, Informatics in Education, 2003, Vol. 2, No. 1, 3-14

A teacher demand and supply forecast was carried out by Merkys et al in 2006[20]. The model used took all the major elements such as pupil forecast, teacher replacement, ITT graduate employment and other factors into account. It was forecast that there would be 109 thousand pre-school pupils in 2015, the actual number for that year was about 122 thousand pupils. It was also forecast that there would be approx. 355 thousand general education pupils in 2015, the actual number at the time was at around 361 thousand. The authors emphasized that teacher age distribution was the basis for the teacher forecast. It was forecast that due to the average age of a teacher, subject-specific teachers already beyond retirement age would comprise 9-10% of the whole teaching workforce in 2010 and would reach 13-15% by 2015. Overall, it was forecast that job placements for teachers would be reduced by 6% annually up until 2015. It was also emphasized that over one third of all new teachers with higher education degree that entered schools in 2005-2006 would have no teaching qualification. Another similar study was carried by Merkys et al in 2008[21]. The main drawback of these analyses is that no data on ITT graduate employment was available at that time.

In 2014, T. Petkus and I. Karaliun[22] provided a forecast for teachers in general education schools and focused on life science, mathematics and technologies subject-specific teachers. In their introductions, the authors clearly stated that continuous analysis would be needed to determine the needs for ITT programmes. While providing pupil number estimates, the authors noticed that an average "drop-out" rate for children who were born and started school was at around 6.3%, which was a bit higher than estimates by Dzemyda et al (2.9%). An interesting observation on the positive relation between the country's economic development and average teacher age was given. The authors provided a forecast for targeted subject-specific teachers up until year 2023, which is the longest forecast available in any of the literature reviewed. That study concluded that a shortage in mathematics and chemistry teachers would start in 2018, technologies in 2020, biology in 2022 and IT in 2023. A weak point of inter-regional disparities is mentioned implying a need for a thorough regional level analysis.

A rather different approach to determine the needs of workers in different economic sectors was taken in a 2013-2015. A model "ZIPS"[23] was created to provide forecasts on labour demand and supply by occupational and qualification clusters. The model was created by the Public Policy and Management Institute (PPMI), commissioned by the Ministry of Economy in 2013–2015 and renewed in 2018. The newly created model forecast labour demand and supply based on a mathematical ROA-CERGE model that was initially created by the Research Centre for Education and the Labour Market, Maastricht University (ROA) in the Netherlands and used by the Center for Economic Research and Graduate Education – Economics Institute (CERGE) in the Czech Republic. The Lithuanian forecasting model used most of the ROA-CERGE model components.

By using aggregated historical data on macroeconomic forecasts, employment by sector of economic activity, new labour market entrants, HE graduates and other data, the project team prepared mid-term, 5-year (2018-2022) forecasts by 21 occupational and 19 qualification clusters. In addition to the forecasting model, labour market monitoring indicators by 92 occupational clusters were calculated. In the case of teachers, the forecast provided for a broad cluster of occupations consisting of: higher education lecturers; pre-school, general and vocational education teachers; education specialists and other specialists; teaching assistants; and managers in the education sector. It was anticipated that in comparison to 2017 the overall demand for this sector would increase by approx. 11.96%, mainly representing replacement needed (11.75%) and a very low increase in expansion of the sector (0.21%). It was also anticipated that in comparison to 2017, the supply in teaching qualification from higher education would increase by 7.8% and the demand for this qualification would increase by 15.3%. The model did not differentiate between school type, subject specific teachers and other levels of detail.

[20] Prof. G. Merkys et al (2006), *Mokytojų poreikio prognozė*, Kaunas 2006
[21] Prof. G. Merkys, S. Balčiūnas, tyrimo ataskaita *Bendrojo lavinimo mokyklos mokytojų poreikio prognozė*, Pedagogų profesinės raidos centras, Kaunas, Šiauliai 2008.
[22] T. Petkus, I. Karaliun (2014), *Mokytojų poreikio tyrimas*, Lietuvos matematikos rinkinys, Lietuvos matematikų draugijos darbai, ser. B, 55 t., 2014, 100-104
[23] The results and more information on the model can be found on www.zips.lt

4.2. FOREIGN MODELLING EXAMPLES

The project team conducted an exploratory analysis of some practice examples of foreign models used to plan the teacher workforce demand at a policy making level. In some cases, research on models was limited due to a language barrier.

According to a recent Eurydice report on Teaching Careers in Europe[24], the majority of countries in Europe engage in teacher workforce forecasting and planning. Approaches differ in various aspects such as timespan, inputs, methods, level of detail and direct application in policy making. Seven education systems are mentioned as carrying out long-term planning. Eurydice also found that most of the forward planning is done by a top-level authority and only in the education systems of Sweden, Austria, Switzerland and Scotland do local-level authorities carry out teacher supply and demand studies in addition to those carried out at the top-level. Furthermore, the most common challenge experienced by most of the countries which use forecasting tools, is shortage in specific subject or geographical area, ageing teacher population, and attracting and retaining young teachers in schools.

Below, we will provide information on selected examples one of which being a very comprehensive, well-developed model for England and the other, an ongoing development for the teacher sector in Ireland. An overview indicating the model criteria described in the Figure 10 is provided.

THE TEACHER SUPPLY MODEL FOR ENGLAND

The Teacher Supply Model (TSM)[25] is used by the Department for Education (DfE) in England to estimate the number of postgraduate initial teacher training (ITT) places needed each year to meet the demand for newly qualified teachers (NQT). The model is used to allocate ITT places to providers and to assess how well the department has been performing in recruiting teachers and to model ITT bursaries. For example, the 2018-2019 TSM estimates ITT place requirements for the 2018-2019 training year. The scope of the model covers state-funded primary and secondary schools, including academies and free schools in England. Independent, special, Scottish/Welsh (which have separate systems) and other schools are outside the scope of the model but are covered indirectly. The model was established and has been used for over a decade. There is an internal steering group and an external technical user group supporting the model development and result application processes.

The TSM is a "stock and flow" model, where stocks can be described as the number of teachers currently employed at schools and in the future, flows – the number of teachers expected to leave the stock (require replacement) and number of teachers expected to enter teaching profession. The model uses historical and current data to inform what is going to happen in the future and bases assumptions on evidence and data. The TSM accounts for: pupil number and demographic changes; number of teachers leaving due to different reasons; teacher demographics; new policies; teachers entering the stock via different routes other than as NQTs; not all trainees completing training and gaining posts in the state-funded sector in the following year. User testing for Pupil-teacher ratios, pupil projections and other inputs are available.

Data sources

The model uses several primary and secondary data sources. The School Workforce Census provides data on current teacher stock, its demographics and subject information as well as data on teacher flows and their routes. Econometric wastage projections provide wastage rates and how they are expected to change over time from current levels. The source of projections is an external Econometric Wastage Model developed by the DfE. Another external model output, pupil population projections, is used in the

[24] European Commission/EACEA/Eurydice, 2018. *Teaching Careers in Europe: Access, Progression and Support.* Eurydice Report. Luxembourg: Publications Office of the European Union.
[25] More information on the Teacher Supply Model can be found on https://www.gov.uk/government/statistics/teacher-supply-model-2017-to-2018

TSM. Other data such as the proportion of trainees that complete ITT programmes and the proportion of those that successfully enter teaching posts afterward is used.

Key assumptions

Several key assumptions are made in the modelling process. One important assumption for the forecasts 2018-2019 is on the future Pupil:Teacher Ratios (PTR). TSM uses historical data on PTRs and pupil number to make assumptions as to how PTRs and therefore teacher numbers will change in the future. Historically PTRs have risen and fallen as pupil numbers have. Part of the additional demand for teachers in the past has been met by increasing PTRs, and therefore class sizes. Different assumptions for primary and secondary PTRs are made. Numbers of secondary teachers in each subject using pupil numbers and subject-level teaching and teachers' data are estimated.

As an example, English Baccalaureate (EBacc) was introduced in 2010 to prevent the fall in the number of students studying foreign languages and science. To enter the EBacc, pupils are required to take GCSE-level examinations in English Language and English Literature, Mathematics, two or three science subjects, History or Geography, and an ancient or a modern language. The 2017-2018 TSM included a planning assumption of increased EBacc take-up from current levels up to 70% for GCSE examinations in the summer of 2020. The 2018-2019 TSM uses an assumption that take-up rates will increase up to 75% for GCSE examinations in the summer of 2024. These assumptions change impacts upon Modern Foreign Languages (MFL) so that MFL teaching does not need to increase quite so rapidly as assumed before but they also effect the non-EBacc subjects. Therefore, EBacc assumptions have had a positive impact on ITT places for the non-EBacc subjects.

Challenges

There are several potential challenges facing the TSM. The first is that both primary and secondary pupil numbers are growing. In addition, it may be harder to recruit teachers as the economy is growing and relatively speaking teachers earn lower wages compared to professional averages. As the economy deflates, the teacher profession is more attractive since there are fewer employment opportunities outside teaching. In addition, internal teacher movement between schools adds more "churn" to the system and this has not yet been accounted for in the model. The previously mentioned EBacc means that more teachers need to be recruited for the subjects that have historically been more difficult to recruit to. Furthermore, there may be different teacher shortage/ oversupply situations in different regions of England.

Table 9. Overview of the Teacher Supply Model in England based on the model criteria selected

Criteria	
Data needs	▪ Pupil population projections from the Pupil Projection Model. ▪ Teacher leavers and entrants' data from School Workforce Census: teachers leaving active stock as wastage, retirements, deaths; data on characteristics (age and gender) of entrants by all entrance routes (snapshot of November). ▪ Teacher stock data from School Workforce Census: teacher characteristics; secondary subject timetable; teachers' FTE rates; teachers' qualification status (snapshot of November) ▪ Projected teacher wastage rates from the econometric Wastage Model.
Level of detail	▪ Historical data from 1970-2010/2013 is used to calculate outputs for 2015/2016 – 2026/2027. Each year the model is updated with the data from the latest Censuses. ▪ Only the teachers employed in regular roles within the state-funded schools are considered by the TSM (nursery, primary and secondary). ▪ The Secondary active stock is broken down by subject (19 groups) by using assumptions as to how much work (proportionately) is spent teaching different subjects by the total stock. ▪ Wastage calculations broken down to 3 teaching subject groups and age cohorts.

	▪ Most of the inputs/outputs are broken down by age group and gender
Flexibility	Scenarios available: Part 1. Impact on teacher need and entrant teacher need by altering future teacher wastage rates by gender; projections of pupil population; projections on how the active stock (via PTR) will change; Part 2. Impact on the postgrad ITT trainee need by altering proportions of newly qualified entrants expected among entrants in active stock;
Automated	The model is broken down into two parts, which inputs and outputs are given in two different interactive platforms on Excel. Both documents contain various tabs with calculations that are clearly explained.
Relevancy	Some policy changes are included in TSM. For confirmed government policy, the model assumes the expected direction from the announced policy; if a government position has yet to be announced, a range of scenarios is modelled in line with government policy and the central scenario is presented.
Application	Every year the Department for Education allocates places to ITT providers and School Direct lead schools to provide courses to train new teachers to enter the profession in the state-funded sector in England. Using the outputs of the TSM, the National College for Teaching and Leadership (NCTL) allocates places to ITT providers and School Direct lead schools. Actual decisions about the employment and deployment of teachers at a school level fall under the responsibility of schools themselves.

IRELAND

Demographic and economic context

Four years ago, Ireland was emerging from a very serious economic recession and there was a high unemployment rate. It was reasonable to anticipate that all ITE graduates would stay in Ireland and take up the available teaching posts. Since then, the economy has boomed again; unemployment rates have plummeted; there is a baby boom and renewed inward migration. Ireland has become more culturally diverse – it is estimated that between 10% and 15% of the school-going population were born outside Ireland. In some schools the proportion of newcomer children can be as high as 50%. There is a shortage of housing, especially in the cities and therefore teachers cannot afford to live in the cities. Countries in the Middle East (e.g. Dubai, Saudi Arabia etc) are offering attractive financial packages to entice Irish teachers to emigrate there. As a result of these unanticipated factors, Ireland has a shortage of NQ (newly qualified) teachers this year.

Initial teacher education (ITE)

Until 2012, there were 19 publicly funded teacher education providers with over 30 accredited programmes all around the country. Following a policy of rationalisation, there are now six Initial Teacher Education centres of excellence that provide research, best practice, support and leadership in teaching and education. All teachers must complete at least a Bachelor's degree (240 ECTS credits). The entry to ITE is highly competitive, attracting those in the top academic 15%. Prior academic performance is the key criterion used for entry to most ITE courses. Initial teacher education programmes are provided separately for primary and second-level teachers. Most primary teachers complete a four-year (240 ECTS) programme, but some complete a consecutive postgraduate two-year

programme. Most post-primary teachers complete a two-year Masters degree in Education (120 ECTS), following a Bachelors degree (minimum of 180 ECTS) in a specific subject or subjects.

The Ministry for Education controls the number of students admitted to initial teacher education courses for primary teachers. There is a *numerus clausus* for each provider. The Ministry does not control numbers of students admitted to courses for second-level teachers. Each provider decides how many students to accept. Most consecutive second-level ITE providers for second-level teachers do not select on a subject-specific basis. This can result in an undersupply of teachers in some subjects and oversupply in others. "The Review Panel's vision for the structure of ITE provision in Ireland is that by 2030 Ireland will have a network of teacher education institutions based on a small number of internationally comparable institutes of teacher education. Each of these institutions will offer research-based teacher education in internationally inspiring environments." (A Review of the Structure of Initial Teacher Education Provision in Ireland, 2012)[26].

The reforms undertaken in 2012 have brought a greater emphasis on numeracy and literacy and research-informed practice. ITE programmes now provide content which focuses more on education-related subjects. Colleges were incorporated into universities and within and between collaboration was enhanced. Furthermore, greater collaboration between institutes, ITE Centres and schools was achieved. However, there were many challenges for this change to happen. A lot of different reforms were carried out during the same period of time. Various resource issues, challenges in HR, IR and legal ownership arose. Consequently, there were new demands on students and schools.

Teacher supply

The Technical Working Group (TWG) was set up following an agreement between the Department of Education and Skills (DES) and the Teaching Council that an analysis of arrangements for the planning of the teacher workforce in Ireland should be undertaken. The initial concentration of the TWG has been to seek to provide projections for a model for primary teacher supply while outlining the necessary work which will be required to establish a similar model for the more complex work required at post-primary level (Striking the Balance, 2015)[27]. The Ministry for Education has been advised that there needs to be a Standing Committee or Group which meets regularly to check the Forecasting Model to monitor its effectiveness and to continually scan the economic, social and cultural horizon for factors which might affect the model. For example, in Ireland in the past year some factors have occurred which were not anticipated when the intake into teacher education programmes was approved four years ago.

In spring 2018, the Minister for Education and Skills set up a Steering group to advise on and assist in developing a comprehensive, flexible and transparent forecasting model for teacher supply and demand at both primary and post-primary levels. The Steering Committee is currently engaged in this task, recognising that the current data relating to teacher stock is inadequate, especially at post-primary level where more information relating to specific subject teaching and full-time and part-time teachers will be required.

Challenges

Projecting the supply and demand for post-primary teachers is more difficult than for primary teachers. There are different categories of post-primary schools that provide the same curriculum regardless of school type. About 55% are so-called "voluntary secondary schools", individually managed; 25% are managed by regional education boards, and 20% are community or comprehensive schools, also managed individually. In addition, post-primary schools employ teachers on a permanent, or contractual or part-time basis. Other issues concerning projecting teacher supply: pupil enrolments will rise steeply in coming years; teachers of certain subjects e.g. Gaeilge (i.e. Irish language), Home Economics, some science subjects and Modern European Languages, are in short supply; and there is an

[26] Department of Education and Skill, 2012. *A Review of the Structure of Initial Teacher Education Provision in Ireland*. Background Paper for the International Review Team, May 2012.
[27] The Teaching Council, December 2015, *Striking the Balance. Teacher Supply in Ireland: Technical Working Group Report*, June 2015

oversupply of teachers of History, Geography and English. Teacher education providers (i.e. universities) have autonomy to decide on student enrolments, including their subject specialisms.

Table 10. Overview of the teacher supply and demand modelling in Ireland based on the model criteria selected

Criteria	Primary school teachers	Post-primary
Data needs	Three sources: ▪ The projected number of pupils in the system for each school year by Department of Education and Skills ▪ Teaching Council's Register of Teachers. Annual supply/ inflows of newly-registered teachers from accredited teacher education programmes, teachers who qualified abroad, teacher graduates. ▪ DES payroll system. Number of employed teachers, status of employment (primary teachers).	Three sources: ▪ The projected number of pupils in the system for each school year by Department of Education and Skills ▪ Teaching Council's Register of Teachers. Annual supply/ inflows of newly-registered teachers from accredited teacher education programmes, teachers who qualified abroad, teacher graduates. ▪ DES payroll system. Number of employed teachers, status of employment (primary teachers).
Level of detail	▪ No regional level. ▪ Reflects primary teaching workforce only (there are no teaching subjects in primary schools). ▪ 2015-2020 annual pupil projections.	▪ Limited information on Subject specific teachers – and on number of teaching hours for specific subjects. ▪ Limited information on full-time and part-time teachers. ▪ 2015-2020 annual pupil projections.
Flexibility	The model which is planned will enable model inputs to be adjusted	The model which is planned will enable model inputs to be adjusted
Automated	One-time report. Projected figures are calculated for 2015-2020 (each year) using snap-shot of available data.	One-time report. Projected figures are calculated for 2015-2020 (each year) using snap-shot of available data.
Relevancy	Current projections do not reflect any planned changes in the policy	Current projections do not reflect any planned changes in the policy
Application	This Report proposes a way forward in respect of planning for teacher supply in primary schools, no specific recommendations on changes provided. Most of recommendations are on data needs and new Standing Committee formation. A series of working parties has been set up by the Minister for Education and Skills to develop a model of teacher supply and demand.	The Report makes suggestions about work which needs to be undertaken to secure a working model for the post-primary sector. The TWG has, within the time available, found it difficult to bring together the complex data which is needed to plan effectively for the future needs of post-primary schools. More work is currently being undertaken in this regard.

5 RESULTS

Modelling results for the 4-year span of 2018/19 – 2021/22 that are based on the framework and other aspects described in previous sections are provided below. We firstly introduce results for the baseline scenario, which assumptions are given above. Comparison to two other scenarios named Lower Efficiency and Higher Efficiency is given.

5.1. BASELINE FORECAST 2018/19 – 2021/22

All baseline scenario assumptions are summarised and provided in Table 11. More detailed explanations of the pupil, student supply and teacher retirement forecast are provided in Section 3. Assumptions that were not described in detail include forecasts on teachers who leave schools due to outside market opportunities. In addition, assumptions on other teacher supply sources such as the "inactive teacher pool" and non-qualified teachers are made. Information on the need for psychologists from local authorities is used. Altogether, this set of assumptions is considered to design the baseline scenario and results given below in this subsection.

Table 11. A summary of the baseline scenario assumptions

Assumption type	**Baseline scenario**
Pupil forecast	Baseline pupil forecast by total number of classes is based on the statistics of permanent residents, class retention rates between grades and schools during the last 5 years. Higher weightings on more recent data are used.
Contact hours/FTE per teacher	Average number of contact hours per teacher is stable over time and is approximately equal to 18 contact hours or 0,98 FTE.
Retirement rate forecast	The same share of teachers leave schools due to retirement as occurred over the past 5 years.
Forecast on the share of teachers leaving schools to other positions in the labor market	An average of approximately 1,5% of teachers who leave schools annually leave due to outside positions in the labor market.
Legal requirements for specific specialisations	Schools are required to employ a psychologist by law. At the time of analysis only a small share of schools satisfy this requirement. The model implies new psychologist demand that is based on the information gathered from local authorities.
ITT student employment at schools	Historical shares of ITT student graduation and employment at schools are used to forecast the number of graduates entering schools.
Inactive teacher supply (share of employed teachers that graduated from ITT programmes 3-5 years ago and were not active the previous year)	A stable share of teachers who were previously inactive enter schools each year. This share is estimated based on the figures from the last 5 years. A restriction of 10% is used for specialisations in high demand (pre-school teachers only, 2017-2018).

Non-qualified (or not-known qualification) teacher supply (share of employed teachers that are assumed to be graduated from ITT programmes more than 5 years ago and were not active the previous year)	A stable share of non-qualified teachers enter schools each year. This share is estimated based on the figures from the last 5 years. Restrictions are used based on the maximum pool of individuals who could start working at schools. The estimation is based on 31-60-year-old teachers who were not at schools in 2017-2018 but have worked at schools at least once in 2010-2016.

The new teacher demand in 2018/19 denotes the additional number of individuals needed at schools to change teachers who retire, to accommodate changes in pupil number and other above-mentioned aspects provided in Table 12. The highest demand is for pre-school (262 individuals) and primary school teachers (248). Approximately half of the demand for new pre-school teachers is due to 187 teachers who will need to be replaced because of retirement. In contrast, only approx. 80 primary teachers are expected to retire in 2018/19. The lowest demand for teachers can be seen in Economics (3), Basics of Civil Education and IT (6). It is therefore fair to conclude that no additional measures are not needed to cover the slightly increased demand for the previously listed specialisations due to possible measurement errors.

If we compare the size of the expansion and substitution demand for 2018/19 to the teacher number in the previous school year 2017/18, we can see that the demand in most specialisations is driven by the substitution factor. Teachers who leave schools due to retirement or outside opportunities need to be replaced by new teachers assuming that those who stay do not take over the contact hours of those who leave. The expansion demand due to changes in pupil population is higher only for several specialisations. There will be a need of approximately 3 percent larger teacher population in Primary school, Pre-primary (5%) and Psychologist (27%) specialization. An assumption that takes into account legal requirements for psychologists at school, drives the demand. On average, 2% larger teacher population per specialization is needed to accommodate ageing teacher population in 2018/19. It is forecast that no substitution is needed in the Social Educator specialization.

Due to the low graduation and employment coefficients, it is forecast that in total only 126 individuals can supplement schools in 2018/19. The total pool of students who are expected to graduate is 848. However, due to historical information on the student employment at schools, only 13% are expected to receive employment. 244 students are expected to graduate in Physical education and 102 could start their career as Social Educators. Due to numerous reasons, frictions in making decision to become a teacher clearly exist. These frictions might represent issues of different origin – lack of personal motivation, career opportunities that do not match expectations, study programme satisfaction etc. Further investigation as to what drives an ITT graduate to opt for a teaching career is needed to recommend targeted interventions and possible changes in existing policies. It is also likely that newly introduced teacher payment scheme and career development stages such as the proposed official induction period will have an influence on graduate employment in the near future.

Other sources of supply are inactive teachers and individuals who were previously not qualified or have an unknown qualification (due to the time-period of historical educational data). If we look at the number of ITT graduates who graduated 3-5 years ago, hold a qualification in teaching, and started working at schools in 2017/18, we see that this number is approximately 200 individuals. The total pool of inactive teachers who have a qualification and could actually teach is approximately 8540. The size of the inactive teacher pool is explained by the low graduate employment rates. It is likely that these individuals are employed and work at public, non-governmental or other sector positions where a qualification in teaching is valued. ITT graduates in the fields of STEM or IT, who mainly represent professions that are in constant shortage in the general labour market, are likely to work in positions that require subject-specific knowledge.

If we look at the annual addition to the teacher population, another group of new teachers can be identified. Approximately 1600 individuals who graduated 5 or more years ago started working at schools in 2017/18. These could be teachers who had teacher experience in their career and later dropped out. This group may also represent individuals who were never employed as teachers and had

work experience elsewhere. In order to estimate a possible pool of individuals in the market who can be attributed to this group and are likely to join schools we assume that at least one-time experience at school represent willingness to work. The size of this pool that is within our data frame is estimated to reach 7520. Therefore, it is likely that all three sources of teacher supply switched in some time in history and recent graduates do not represent the highest share of newly recruited teachers each year. Furthermore, there is a large number of individuals in the market who are able or willing to join schools.

We can now look at the results for the baseline scenario 2018/19 (Figure 25). Having in mind the size of teacher expansion and substitution demand, low graduate employment and large influx of inactive teachers, there is projected to be a shortage of 126 individuals in 2018/19. If we look at specialisations, differences can be seen. The highest shortage can be seen in teachers for primary schools where overall a shortage of 177 teacher is expected. Even if all ITT graduates receive employment, a shortage of over 100 teachers would occur. Therefore, other type of short-term measures are needed to cover the shortage in primary schools. Shortages of over 20 individuals can be seen in specializations such as Lithuanian language (24), Mathematics (25), Other foreign languages (29), Grade 0 (55) and Psychologists (109). Higher ITT student graduation and employment rate would help to cover shortages in Lithuanian language and Grade 0 teachers and only partially for other listed specializations.

A surplus for Social educators (37) and Pre-school tutors (284) in 2018/19 is expected. If we look again at the pupil forecast for preschool children, we can only see a slight increase in pupil number when comparing 2017/18 and 2018/19 (Table 6). In addition, approximately 3% of teachers will need to be replaced. A high number of individuals who are not recent ITT graduates or active teachers join pre-schools every year but are not needed to accommodate changes in pupil number or teacher population. However, there might be differences across municipalities that cannot be calculated within the pilot model. The pre-school participation is higher in the city locations (72%) and much lower in rural area (35%[28]), therefore, a national surplus might not represent situations in certain municipalities that might be growing in number.

A cumulative 4-year forecast represents the overall teacher surplus or shortage if nothing changes. The highest 4-year shortage can be seen among Primary school teachers, which add up to approx. 700. The main driver for the Primary school teacher baseline scenario is an increase in the primary pupil class number by 8-11% annually. Other significant shortages in Lithuanian language and Mathematics might reach up to 200 individuals in 4 years' time. The shortage in Pre-primary teachers will more than double in size and reach approximately 123 individuals. Due to differences in cohort sizes, the overall surplus for Pre-school tutors will reduce to 229 in 4 years. Foreign language teachers (English and Other) will face a shortage of 171 and 159 respectively. Therefore, changes in the ITT student admission might be one of the main keys to overcome the shortages in midterm.

While analysing these results, assumptions made must be kept in mind. Changes in system such as pupil-teacher ratio, teacher payment scheme, school network and the recent establishment of 3 ITT centres are likely to impact the short-term and mid-term forecasting results. In the light of the ongoing reforms, it is likely that structural changes in teacher demand and supply will be seen in the next phases of model updates. Therefore, to illustrate the different possible situations, two other scenarios are introduced and presented below.

[28] Enrolment in preschool and pre-primary education in 2017, Statistics Lithuania.

Table 12. New teacher demand in 2018/19 and sources of supply: baseline scenario.

Specialisation	New teacher demand 2018/19	Student supply		Inactive teachers		Non-qualified teachers	
		Forecast	Max pool	Employed at schools 2017/18	Max pool	Employed at schools 2017/18	Prospective employees 2018/19*
Biology teacher	10	2	16	2	117	11	187
Chemistry teacher	24	1	1	0	28	12	100
Art teacher	23	2	15	2	400	28	237
Religion education or Ethics teacher	39	2	17	5	260	50	527
Economics teacher	3	0	0	1	-	5	138
Physics teacher	25	1	1	0	50	17	171
Nature and Human Being teacher	10	2	12	3	118	8	33
Geography teacher	17	2	18	5	235	16	135
Native language (other) teacher	9	1	9	0	140	6	61
History teacher	21	3	27	2	237	32	262
IT teacher	6	2	7	1	218	20	175
Physical education teacher	55	10	244	8	1287	37	393
Lithuanian language teacher	77	3	37	11	349	59	685
Mathematics teacher	53	1	2	2	106	36	445
Music teacher	68	12	76	11	559	44	315
Basics of Civil Education teacher	6	1	5	2	550	15	3
Primary school (grade 1-4) teacher	248	11	48	10	195	127	366
Technologies teacher	23	2	13	2	196	22	118
Foreign language (English) teacher	62	5	34	5	375	78	518
Foreign language (Other) teacher	70	1	12	3	174	33	297
Human Safety teacher	13	0	0	0	-	5	40
Pre-school tutor	262	20	80	86	254	702	1671
Pre-primary (grade 0) class teacher	120	18	72	7	248	82	119
Psychologist	159	0	0	1	-	68	155
Social educator	23	10	102	22	2444	51	179

**Teachers of age 31-60 that were not working at schools in 2017/18 but were at least once employed in the period of 2010-2016.*

Table 13. New teacher demand in 2018/19 as compared to 2017/18: baseline scenario.

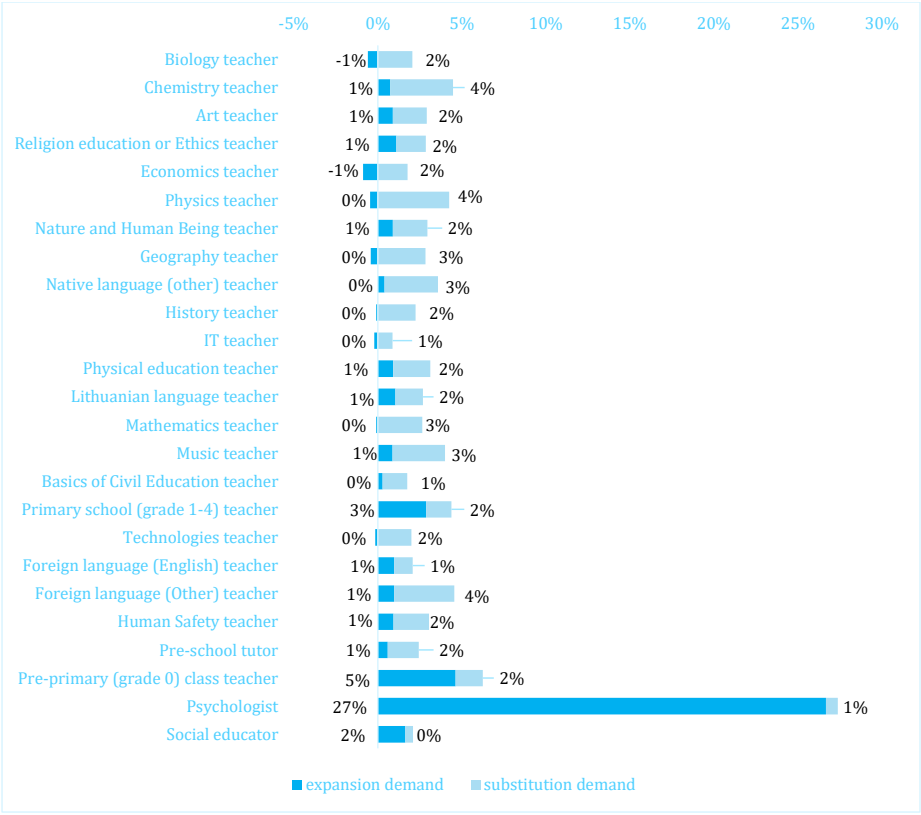


Figure 25. Teacher shortage (+) or surplus (-) by specialisation in 2018/19: baseline scenario

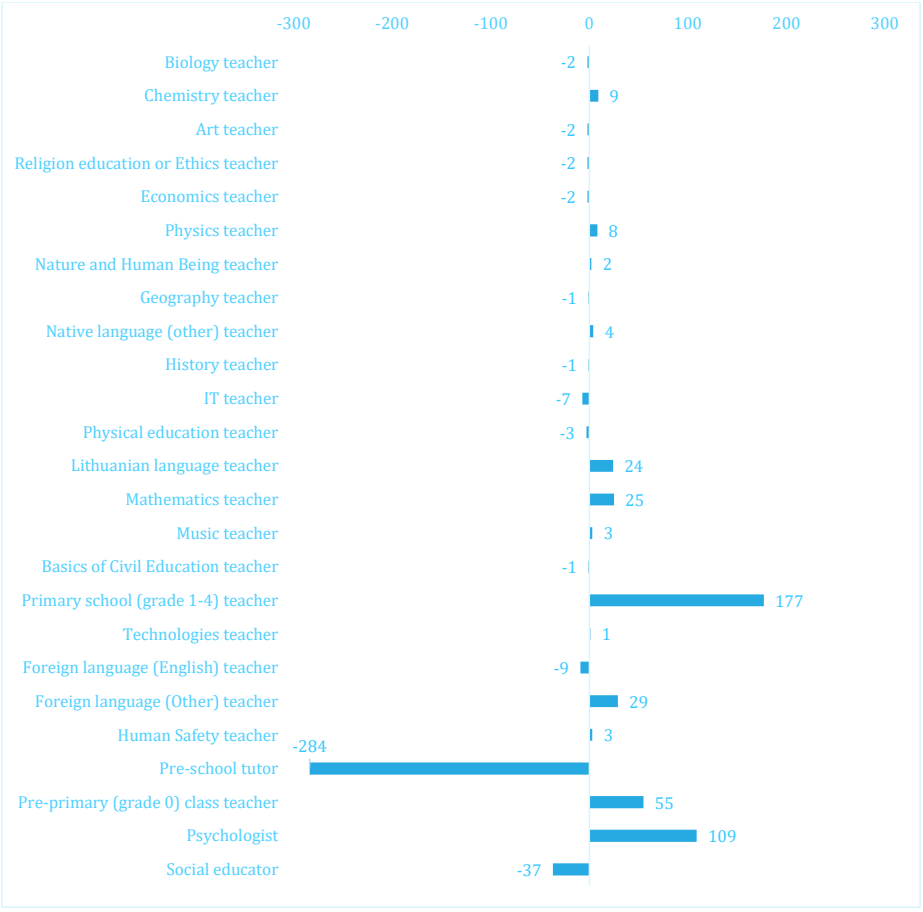
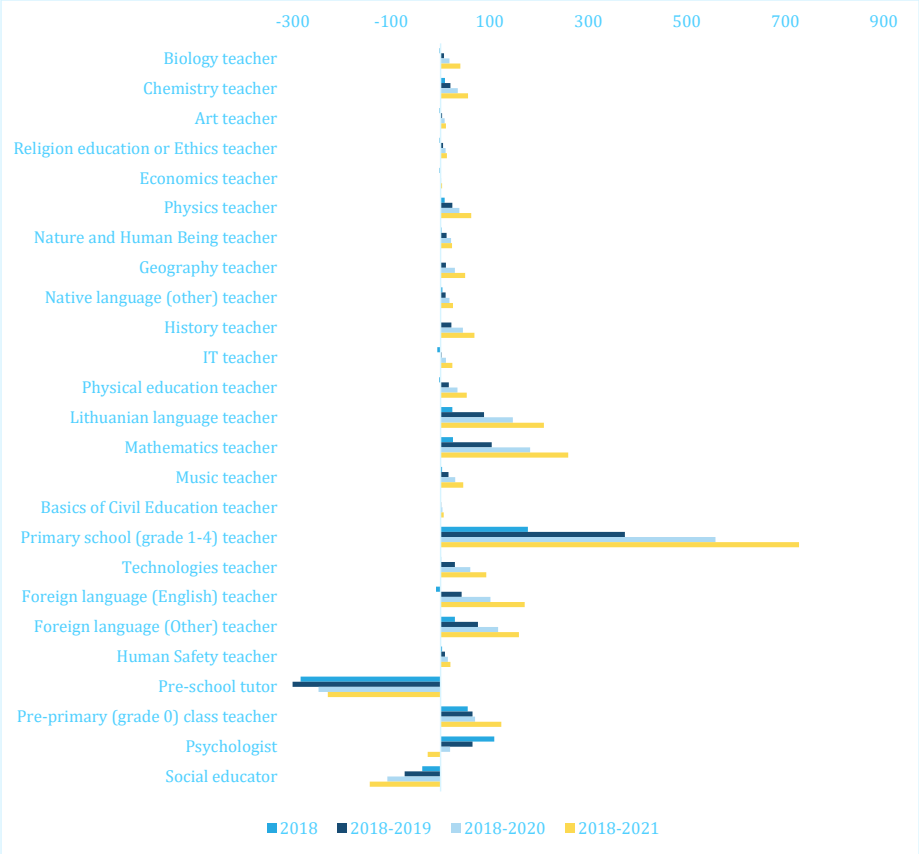


Figure 26. Cumulative teacher shortage (+) or surplus (-) in 2018/19 - 2021/22: baseline scenario



5.2. SCENARIO TESTING 2018/19 – 2021/22

To demonstrate the flexibility of the model and possible situations ahead, in addition to the so-called baseline scenario, two other scenarios are suggested. We describe the main distinction between scenarios as "efficiency" level denoted by pupil forecast, retirement rate and other modelling elements. For the lower efficiency (LE) scenario, it is assumed that the pupil population will continue decreasing and due to that teachers work 1 contact hour per week less. In addition, the retirement rate is lower than the historical rate used for the baseline. In contrast, the higher efficiency (HE) scenario assumes higher increases in pupil population, higher than historical retirement rates and 3 contact hours increase per teacher. All assumptions made, similar to the description of the baseline scenario provided in the previous section, are given in Annex A3.

If we look at the total teacher shortage/ surplus, the overall situation in the LE scenario is a shortage of 875 teachers in 2018/19 as compared to the baseline of 98. Considering HE, there is an overall surplus of 708 teachers. This illustrates the possible changes in the situation if different retirement, employment and other rates are assumed. All three scenarios forecast that there will be a shortage for Primary school teachers in 2018/19, the highest shortage can be seen under the HE (262 individuals). This indicates that targeted interventions are needed to steer the teacher shortage and satisfy the need with an in-depth analysis on the reasons for it. The surplus for Pre-school tutors is visible across all three scenarios, however the highest (284) is seen under the assumptions of the baseline scenario. Other specialisations such as Psychologists, Foreign language (other than English) and Mathematics indicate shortage across the two scenarios.

Detailed new teacher needs forecasts by specialisation, scenario and forecast year are given in Table 15. It is important to note that different combinations of assumptions can also be made to construct new scenarios. This function is provided for users in an interactive tool that is published together with the report.

Table 14. Scenario comparison by aspect for 2018/19.

	Baseline scenario	**Lower efficiency scenario (LE)**	**Higher efficiency scenario (HE)**
Total teacher shortage (+)/ surplus (-)	98	875	-708
Highest shortage specialisation (+)	Primary school teacher (177)	Primary school teacher (159)	Psychologist (554)
Highest surplus (-) specialisation	Pre-school tutor (- 284)	Pre-school tutor (- 156)	Pre-school tutor (- 267)
5 specialisations with the highest teacher shortage (+)	1. Primary school teacher 2. Psychologist 3. Pre-school tutor 4. Foreign language (other) teacher 5. Mathematics teacher	1. Primary school teacher 2. Pre-school tutor 3. Music teacher 4. Foreign language (other) teacher 5. Physical education teacher	1. Psychologist 2. Primary school teacher 3. Mathematics teacher 4. Lithuanian language teacher 5. Foreign language (English) teacher

Table 15. New teacher need in surplus (-) or shortage (+) by specialisation, scenario and forecast year

Specialisation	Baseline scenario				Lower efficiency (HE)				Higher efficiency (LE)			
	2018/19	2019/20	2020/2021	2021/22	2018/19	2019/20	2020/2021	2021/22	2018/19	2019/20	2020/2021	2021/22
Biology teacher	-2	9	11	22	3	6	13	25	-1	5	12	30
Chemistry teacher	9	11	15	21	15	9	18	25	10	8	19	25
Art teacher	-2	5	5	3	39	5	8	9	-102	-5	-1	3
Religion education or Ethics teacher	-2	7	5	3	67	5	4	5	-204	-9	-5	-3
Economics teacher	-2	1	2	2	17	-1	2	3	-56	1	2	3
Physics teacher	8	16	14	24	13	11	17	28	5	17	18	31
Nature and Human Being teacher	2	10	9	2	20	9	10	5	-53	7	7	4
Geography teacher	-1	12	18	21	3	8	22	28	-5	6	18	27
Native language (other) teacher	4	6	8	7	13	7	10	9	-5	4	8	6
History teacher	-1	23	23	24	-1	19	32	38	-2	11	21	33
IT teacher	-7	9	9	13	37	7	15	21	-61	7	12	21
Physical education teacher	-3	20	17	19	82	11	18	24	-259	-114	-88	-72
Lithuanian language teacher	24	64	59	63	32	45	59	69	57	59	65	83
Mathematics teacher	3	79	78	77	21	61	82	89	60	85	91	104
Music teacher	3	13	14	16	104	20	27	27	-208	-10	1	5
Basics of Civil Education teacher	-1	2	3	2	20	2	3	4	-59	-3	-2	1
Primary school (grade 1-4) teacher	177	197	184	170	159	168	134	133	262	112	71	60
Technologies teacher	1	28	31	33	45	22	34	40	-48	21	29	40
Foreign language	-9	52	58	70	11	43	67	78	26	22	31	50

(English) teacher												
Foreign language (Other) teacher	29	47	41	42	97	37	43	46	-96	43	38	45
Human Safety teacher	3	6	6	5	26	5	6	8	-66	6	7	9
Pre-school tutor	-284	-62	98	19	-156	130	201	126	-267	-405	-433	-518
Pre-primary (grade 0) class teacher	55	10	5	53	131	22	18	66	-60	-92	-105	-56
Psychologist	109	-44	-46	-45	80	2	9	10	554	-44	-45	-43
Social educator	-37	-36	-35	-36	-3	-17	-7	-1	-130	-88	-74	-63

CONCLUSIONS AND RECOMMENDATIONS

TEACHER SUPPLY PLANNING PRACTICE

As in many other countries of the EU, Lithuania needs to put in place evidence-based policies and clear processes for planning and managing the teacher workforce. These policies and processes should include a clear timeline, the involvement of stakeholders and clarification of their functions, as well as methods used to determine the annual cycle of budget allocation for ITT admissions. The cooperation of ITT centres, policy makers, professional unions and other stakeholders are needed to provide coherence in the teacher planning system.

In the light of ongoing reforms of the teacher payment scheme in Lithuania, the ITT centre network and professional development, it is likely that factors driving the supply and/ or demand for teachers will change. However, until specific decisions are made and implemented, the forecasting model cannot predict with any degree of accuracy the exact changes in factors driving the demand such as teacher retirement rate, teachers leaving the profession for outside labour market opportunities, or those driving supply such as ITT students' graduation and employment rate. (The two alternative scenarios suggested in paragraph 5.2. of this report, illustrate the possible deviations from the baseline teacher need, depending on what policy decisions are taken).

- It is recommended that a group be set up, coordinated by the Ministry of Education and Science, that would routinely meet to ensure teacher planning practice and implementation of the processes needed to gather all necessary information and data.
- It is recommended that representatives from ITT centres, local authorities, professional unions and analytics be included in this group, to ensure that decisions taken by the group represent ongoing concerns, issues and needs of the education community,
- Resources should be allocated to support the ongoing work of the group.

FURTHER MODEL DEVELOPMENT

During the lifetime of this project, the team was able to investigate the theoretical sources of teacher planning, some existing examples of planning systems in Europe and develop a model that we believe will provide a basis for teacher supply planning in Lithuania. Work on data collection, preparation, algorithm development was carried out to produce short and midterm forecasts of teacher need. Elements of a teacher demand and supply model were developed in a rather short period of time. The team believes that further work to develop the model is needed to ensure the reliability and comparability of the forecasting results.

- Further development of the model will be required to incorporate all the data and information necessary for a comprehensive teacher workforce model. Such development would include specialisations not currently included in the model as well as further detail regarding level and sector of teachers.
- A higher level of automation, especially links with primary data sources, will be required to reduce the time needed for annual model renewal.
- Resources should be allocated to support further model development.

ASPECTS RELATED TO TEACHER DEMAND

As regards the baseline scenario, the total number of pupil classes is forecast to increase by 7% from 2017-2018 to 2021-2022. in this event, the total class number is likely to increase, on average, by 2% annually.

We forecast that 3077 teachers who worked at schools in 2017-2018 will leave due to retirement within the 4-year time period. The largest specializations with the most teachers likely to retire are pre-school

tutors (680) and primary education teachers (306). Teacher retirement, together with changes in pupil population, are the main drivers of teacher demand.

- Regular and ongoing forecasting of pupil numbers will be needed to determine whether the increases in cohorts of young children are temporary or will continue for a longer period of time.
- It is recommended that the retirement incentives for teachers be reviewed. Retirement should be an economically attractive option for teachers who are willing to retire. A once-off lump sum payment to encourage teachers to retire would be a short-term contribution to the overall retired teacher wealth.

INITIAL TEACHER TRAINING AS TEACHER SUPPLY

A challenge to the supply side of the teaching workforce is the low graduation and employment levels of ITT graduates in Lithuania. The total pool of ITT students expected to graduate within the 4-year period is 848. However, based on historical information on student graduation and career take up (employment at schools), only 13% of graduates are expected to start working at schools. In this report, it is forecast that only 126 ITT graduates are likely to enter schools in 2018/19.

- Long term measures contributing to improved working conditions for teachers are likely to increase graduation and employment levels of recent ITT graduates. Such measures should be oriented towards better pay, continuous professional development, and better school environment supporting teachers. Effective implementation of the induction period for newly qualified teachers will be crucial to retaining teachers at the start of their career.
- Revised ITT programme curricula that emphasize subject specific knowledge and provide skills in teaching may shine a new light on ITT training and attract motivated young people to become teachers. The timespan of changes in curriculum should be considered because it is likely to take 3-4 years (the length of the study programme) before the changes affect the teaching market.
- The proposed involvement of the newly established ITT centres in a collaborative teacher workforce planning team will provide a platform for engaging them in the change process. With respect to the independence of HEIs, a clear strategic vision on teacher training in Lithuania is crucial to steer the work of ITT providers.
- It is recommended that an analysis of student satisfaction to identify the reasons for ITT student dropout be conducted.
- Short term measures such as increased scholarships for ITT students are likely to contribute to higher number of students entering ITT programmes. However an increased number of scholarships may not result in an increased number entering employment. Moreover, there is a risk that increasing the student "basket number" for ITT studies may not attract motivated school leavers. Lack of competition among candidates could impact negatively on the overall quality of the ITT programmes.

SPECIFIC ISSUES WITH OVERALL TEACHER SHORTAGE OR SURPLUS

We forecast a shortage of 98 teachers in 2018/19 for specialisations that are within the model scope. The highest nominal shortage can be seen in teachers for primary schools (177). Even if all ITT graduates receive employment, there would be a shortage of over 100 teachers. Shortages of over 20 individuals can be seen in specializations such as Lithuanian language (24), Mathematics (25), Other foreign languages (29), Grade 0 (55) and Psychologists (109). A surplus for Social educators (37) and Pre-school tutors (284) in 2018/19 is expected.

The highest cumulative 4-year shortage can be seen in Primary school teachers, which adds up to approx. 700. Other shortages in Lithuanian language and Mathematics might reach up to 200 individuals in 4 years' time. The shortage in Pre-primary teachers will more than double in size and reach approximately 123 individuals. Due to differences in cohort sizes, the overall surplus for Pre-school tutors will reduce to 229 in 4 years. Foreign language teachers (English and Other) will face a shortage

of 171 and 159 respectively. All three scenarios forecast shortages for Primary and pre-school teachers in 2018/19.

- Large numbers of ITT graduates who chose not to work at schools indicate that there is a pool of individuals who were once motivated to become teachers. Programmes dedicated to involving individuals from outside job markets to share their skills and knowledge and become teachers at schools might be effective if targeted correctly. (However, it is important to note that such interventions would not contribute on a systematic basis).
- Reducing qualification requirements is a risk to the teaching quality and to pupil attainment in the longer-term. Therefore, a stronger system of continuous professional development and larger budget allocations for upskilling and requalification and training are recommended.
- It is recommended that the need for more teachers in preschool, pre-primary and primary education be prioritised. If earlier start of primary education is to be implemented and pupil participation in preschool education is to increase in rural areas, there is a risk of an even higher shortage in teacher numbers in those sectors.

ANNEX

A.1. DATA SOURCES

Table. The list of data sources and data entries used in the model

Register name	Year	Educational information	Other characteristics
Pupils' register (class level)	2010/11 – 2017/18	Name of the institution, type of the institution, municipality, ISCED level, grade, class type	–
Teachers' register (anonymised individual level)	2010/11 – 2017/18	Name of the institution, municipality, post title, teaching subjects, number of contact hours, number of additional hours	Age and gender
Students' register (anonymised individual level)	2010/11 – 2017/18	Name of the institution, type of the institution, municipality, ISCED level, year of progression, study programme code, study programme title, professional qualification awarded, number of credits per programme, graduation year	-
Number of permanent residents (Statistics Lithuania)	2010-2017	–	Age, municipality

1. NEW TEACHER DEMAND (Y)

The new teacher demand Y_{ts} is equal to the total number of teacher due to expansion need ED_{mst} and those needed to be substituted minus other sources of teacher supply: inactive teachers *INAC* (qualified, not working in schools), ITT students *STS* and non-qualified (or unknown qualification) teachers that enter school each year *NQ* (e.g. special programmes to encourage teaching):

$$Y_{ts} = \sum_{m} ED_{mst} + SUB_{st} - STS_{st} - NQ_{st} - INAC_{st},$$

where

m – municipality
s – specialisation, described by school type, post and teaching subject
t – year of forecast

Teacher demand (ED)

Total teacher demand ED_{mst} in year *t,* municipality *m* and specialisation *s* is calculated by subtracting the total number of teachers $POOL_{mst-1}$ one year before year t from the total teacher need due to expansion E_{mst} at year *t*:

$$ED_{mst} = E_{mst} - POOL_{mst-1}, \text{ where}$$

1. Total teacher need due to expansion E_{mst} is calculated by firstly deriving average contact hours per pupil (y_{kst}) in municipality *m.*

$$\frac{DH_{mst}}{PUPILS_{st}} = y_{kst}\ (hrs/pupil),$$

By knowing this, the future need of contact hours is calculated by multiplying contact hrs/pupil y_{ks} by the class number projection $PUPILS_{ms\,t+1}$ at year t+1:

$$y_{kst} \cdot PUPILS_{ms\,t+1} = DH_{mst+1},$$

where DH_{mst+1} – total number of contact hours needed for the new projected pupil number in municipality *m* and specialisation *s.*
Pupil class projection $PUPILS_{ms\,t+1}$ at year *t+1* estimated as the total sum of contact hours per projected number of pupil classes needed at year *t+1* is calculated by number of pupil classes at each grade/municipality/location type at year t multiplied by historical retention rate (share of classes that progress from one grade to another). The retention rate is different for grade 0, which is determined based on historical share of pupils that start school at grade 0 in each municipality/location type of total number of children that were and will be (forecasted coefficient) of age 5-6.

To determine the total teacher need E_{mst+1} (headcount) based on the total contact hours need DH_{mst+1} for the baseline scenario we are using 18 contact hours per person. There are two possible ways to determine the teacher need due to expansion E_{mst+1} (headcount):

a) The total teacher need in headcount is equal to the total contact hour need divided by the full time equivalent (FTE_k) definition (which is anticipated to 18 hours/teacher):

$$E = \frac{DH_{mst+1}}{FTE_k}$$

b) If more contact hours are needed at *t+1* than at *t*, the number of total teacher need is equal to the current pool of teachers and the number of additional teachers needed to cover for the increased number of hours. If less contact hours are needed at *t+1* than at year *t*, the total headcount need is equal to the current pool of teachers in the system.

$$\begin{cases} If\ DH_{mst+1} > DH_{mst}, & E = \dfrac{DH_{mst+1} - DH_{mst}}{FTE_k} + POOL \\ If\ DH_{mst+1} < DH_{mst}, & E = POOL \end{cases}$$

2. The substitution demand SUB_{st} equal to the number of teachers leaving schools due to death $DEATH_{st}$ retirement $PENSION_{st}$ and resignation $RESIGNATION_{st}$:

$$SUB_{st} = DEATH_{st} + PENSION_{st} + RESIGNATION_{st}.$$

Suppose x_c is the total number of contact hours needed to be replaced due to death, retirement and resignation. Then the total number of teachers needed to be replaced (headcount) SUB is simply equal to the number of hours x_c divided by the (FTE_k) definition satisfying two FTE using conditions denoted earlier.

ITT students (STS)

Here the total ITT graduate number entering schools is determined by the number of consecutive and concurrent programme students (ST_{CS} and ST_{CR} respectively), multiplied by the graduation (denoted *GR*) and employment (denoted *EM*) rate:

$$STS_{ts} = ST_{CS}q_{GR}q_{EM} + ST_{CR}k_{GR}k_{EM}.$$
$$STS_{ts} = ST_{CS}q_{CS} + ST_{CR}k_{CR}.$$

2. Student admission number (A) *(note: not given in the pilot model)*

The number of students need to be admitted to ITT programmes is calculated from the new teacher need Y, derived during the Phase 1. *A* varies for different HE institutions (*noted by i* in the formula) providing ITT programmes. Each institution and type of study programme (p) have different rates for student drop-out (DR), graduation (GR) and employment (EM).

$$A_{tp} = \sum_{i=1}^{n} (A_{CSi}q_{DRi}q_{GRi}q_{EMi} + A_{CRi}k_{DRi}k_{GRi}k_{EMi})$$

A.3. SCENARIO ASSUMPTIONS

Assumption type	Lower efficiency scenario (LE)	Higher efficiency scenario (HE)
Pupil forecast	It is forecast that pupil population will decrease based on the number of permanent residents, retention rates in the school year 2017/18.	It is forecast that pupil population will increase based on the number of permanent residents, retention rates from the last 3 years with more weight on the recent data.
Contact hours/FTE size per teacher	Due to a forecast decrease in pupil number and stable teacher workforce the contact hours per teacher decreases by 1 hour or 0,025 FTE.	Due to new teacher payment scheme and increased share of teachers leaving schools due to retirement, the number of contact hours per teacher increases by 3 hours or 0,075 FTE.
Retirement rate forecast	It is assumed that the share of teachers leaving due to retirement is 3% lower than on average during the previous 5 years. This assumed share reflects the situation when no measures (for example, targeted fund) to increase retirement were intact.	It is assumed that the share of teachers leaving due to retirement is 3% higher than on average during the previous 5 years. This assumed share reflects the situation in 2017/18 when measures (for example, targeted fund) to increase retirement were intact.
Forecast on the share of teachers leaving schools to other positions in the labor market	Due to economic growth, more teachers leave schools due to outside market opportunities. It is assumed that 3% of teachers that leave schools annually leave due to outside positions in the labor market.	Due to positive changes in teacher payment scheme and other work conditions, less teachers leave schools due to outside market opportunities. It is assumed that 1% of teachers that leave schools annually leave due to outside positions in the labor market.
Legal requirements for specific specialisations	In this scenario it is assumed that the demand for new psychologists at schools is twice smaller than compared to the baseline.	In this scenario it is assumed that the demand for psychologists at schools satisfy legal requirements (1 FTE psychologist per 400 pupils)
ITT student employment at schools	The share of ITT student graduation and employment at schools is lower than historical shares and are not higher than 10% per specialisation.	The share of ITT student graduation and employment at schools is higher than historical shares and is estimated to be equal to 50%.
Inactive teacher supply (share of employed teachers that graduated from ITT programmes 3-5 years ago and were not active the previous year)	A restriction of maximum of 2.5% per specialization is used. The restriction is based on the historical share of inactive teachers entering schools when shortage in teaching workforce was obvious.	Higher than average shares of inactive teachers joining schools are used per specialisation. These shares are based on average group coefficient to which each specialisation can be attributed.
Non-qualified (or not-known qualification) teacher supply (share of employed teachers that are assumed to be graduated from ITT programmes more than 5 years ago and were not active the previous year)	A restriction of maximum 7% per specialisation is used. The restriction is based on the historical share of non-qualified (not-known qualification) teachers entering schools when shortage in teaching workforce was obvious.	A fixed share of non-qualified (not-known qualification) teachers enter schools each year. The share is based on a historical average.

END PAGE (to be added)