

THE TEACHER SHORTAGE: NATIONAL TRENDS FOR SCIENCE AND MATHEMATICS TEACHERS

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Abstract

The shortage of science and mathematics teachers is a growing problem in the United States. This article looks at what research says about the causes for the growing teacher shortage and its effects on student achievement. As the teacher shortage worsens, teachers without a science or mathematics backgrounds are tasked to teach science and mathematics or underqualified teachers are being hired to fill the shortage. These underqualified teachers are not remaining in the profession, thus not solving the teacher shortage problem and creating an even higher turnover rate for teachers. In addition, experienced teachers are leaving the profession in greater numbers due to low salaries and job dissatisfaction. Research indicates that the initial preparation and support of teachers as they enter the profession is critical to surviving the beginning years and remaining in the profession. Additionally, well-prepared teachers have the largest impact on effective classroom practice and high student achievement.

Teacher Shortage

The shortage of qualified science and mathematics teachers is a growing problem throughout the United States. According to the National Commission on Mathematics and Science Teaching for the 21st Century, there is a projected need for 240,000 new science and mathematics teachers in middle and high schools over the next decade [1]. This need is compounded by the current shortage of personnel with technical skills in business and government, and the opportunities in the private sector that offer what many people consider to be more attractive compensation packages and working conditions than are available in the teaching profession [2].

Since the early 1990s, the number of teachers leaving the profession has been greater than the teachers entering the profession by an ever increasing number (see Figure 1 [3]). This is an alarming trend that affects all grade levels, but is especially apparent in secondary schools. Science and mathematics teachers are 11% of the total teaching force, with 22% in elementary or middle schools, 73% in secondary schools, and 5% in schools with grades K-12 [4].

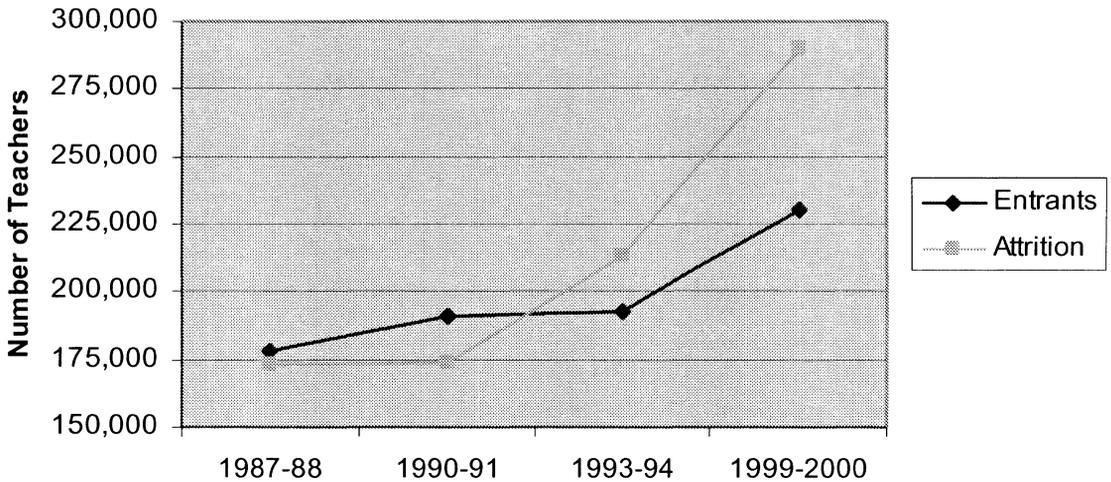


Figure 1. Trends in teacher entry and attrition, 1987-2000.

Learning Shortfalls

Not only is there a shortage of teachers, but also the teaching of science and mathematics in the United States is falling short of the need to prepare future generations with analytic skills [1]. This deficiency in student achievement is documented by the Third International Mathematics and Science Study in which United States fourth graders ranked above the international average in science and mathematics, eighth graders were in the middle of the field, and graduating high school students ranked well below the international average [5-8]. This is due in part, concluded the National Commission on Mathematics and Science Teaching for the 21st Century, to a lack of qualified science and mathematics teachers at the middle and high school levels [1].

Un(der)qualified Teachers

Having highly qualified teachers for every class is especially problematic when the current science and mathematics teachers in the profession do not have science or mathematics

backgrounds. Approximately 25% of high school mathematics teachers and 20% of high school science teachers don't have even a minor in their teaching field [1].

Because of the shortage of science and mathematics teachers, licensed teachers in other subject areas are often asked to teach science or mathematics. For 56% of high school students taking physical science classes and 27% of high school students taking mathematics classes, their teachers are teaching out of field [1]. These percentages are higher in high poverty schools.

New Teachers

As the shortage of science and mathematics teachers increases, more schools are hiring underqualified teachers [1,2,4,9]. Though these teachers usually have a bachelor's degree in science or mathematics, many of these teachers do not have any teaching experience or education coursework. Thus, these provisionally licensed science and mathematics teachers face the extra challenge of discovering how to teach on their own.

With the growing shortage of teachers, the number of under-prepared teachers entering the profession is increasing. More than 12% of new hires begin teaching without any formal pedagogical training, and 26% of new hires do not meet the requirements for licensure in their respective states [1]. Many of these new and under-prepared teachers teach in high poverty and high minority schools.

High Poverty Schools

In high poverty schools, the incidence of science and mathematics teachers teaching without even a minor in science or mathematics, or licensed teachers teaching out of their field is even more frequent. Students that attend schools with a high minority population have a 50% chance of getting teachers in both science and mathematics that do not hold both a license and a degree in the field they are teaching [1]. Quality teaching is further compromised by the shortage of science and mathematics teachers entering the profession. A high percentage of new teachers and unprepared teachers are hired to teach in high poverty level schools [3].

Teacher Retention

Retaining good teachers is important not only for student learning, but also to counteract the teacher shortage problem. Unfortunately, the teacher retention problem is further compromised since a higher percentage of new teachers and under-prepared teachers are hired in

high poverty schools, a setting where many have little first-hand experience. This adds to the challenges of learning on the job.

Research shows that the turnover rate of teachers is 50% higher in high poverty schools than in low poverty schools [9]. Research also shows that regardless of the school poverty level, science teachers have especially high turnover rates and are more likely to leave the profession compared to other subject area teachers (see Figure 2 [4]). This may be due to increased opportunities outside of teaching for people with science and mathematics backgrounds.

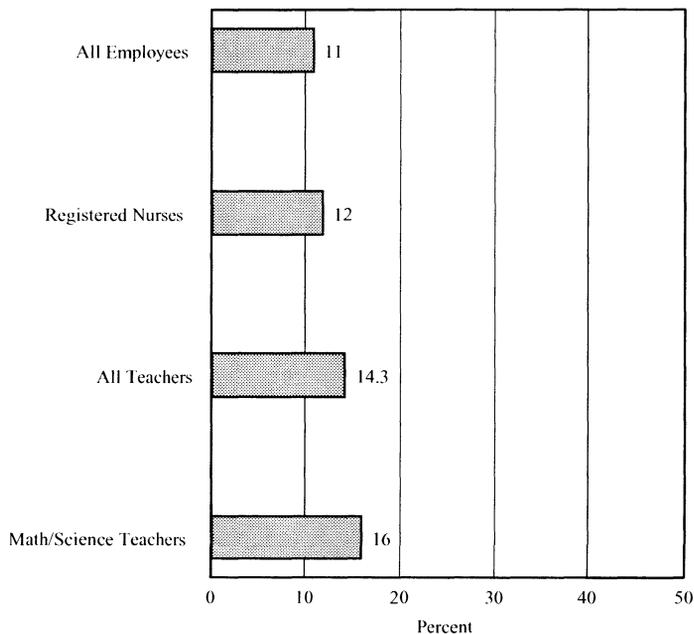


Figure 2. Percent employee turnover, percent nurse turnover, and percent teacher turnover.

According to Ingersoll, there are two types of teacher turnover, attrition and migration, that affect teacher retention [4]. Attrition is when teachers leave teaching altogether. Migration is when teachers move to different teaching jobs in other schools. Teacher turnover is split almost equally among teacher attrition (7.3%) and teacher

migration (7%). For science and mathematics teachers, the turnover rate (16%) is even higher than for teachers in general [4].

Beginning Teachers

Among science and mathematics teachers, beginning teachers have a high rate of departure, the rate for mid-career teachers declines, and then in retirement years the rate increases again [4]. The attrition rate is especially steep for beginning teachers (see Figure 3 [4]). These percentages would approximately double if both attrition and migration rate were included.

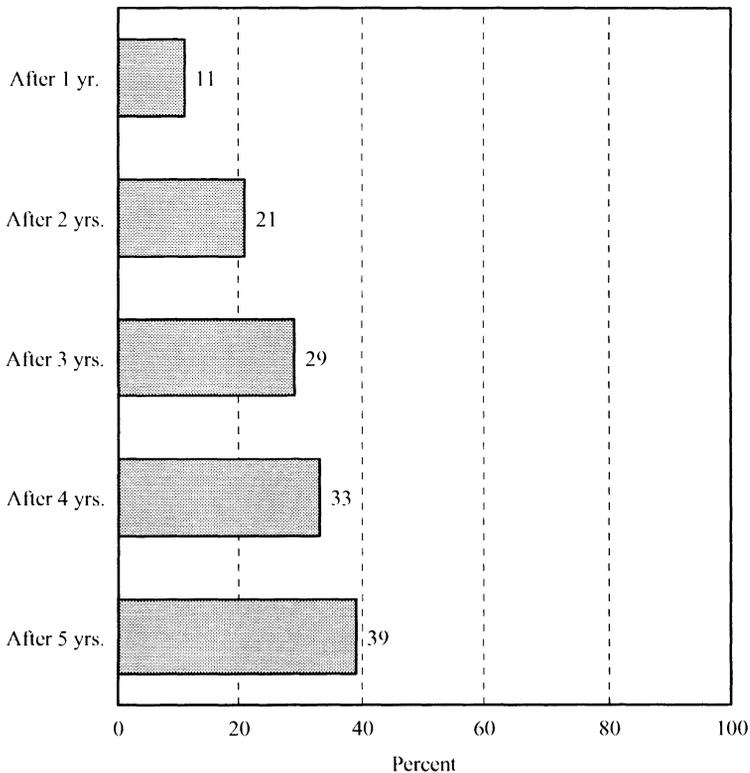


Figure 3. Beginning teacher attrition—cumulative percent of teachers having left teaching occupation by years of experience.

Reasons for Turnover

In general all teachers, including science and mathematics teachers, agree on five main reasons for leaving their jobs. These reasons are family or personal, job dissatisfaction, pursuit of another job, school staffing action, and retirement (see Figure 4 [4]). Conventional wisdom has suggested that teachers leave teaching because of retirement. The data from Ingersoll’s study refutes this claim. For all teachers, one of the top reasons for leaving is family or personal reasons, such as pregnancy and family moves. However, for science and mathematics teachers, the biggest reason for leaving is job dissatisfaction [4].

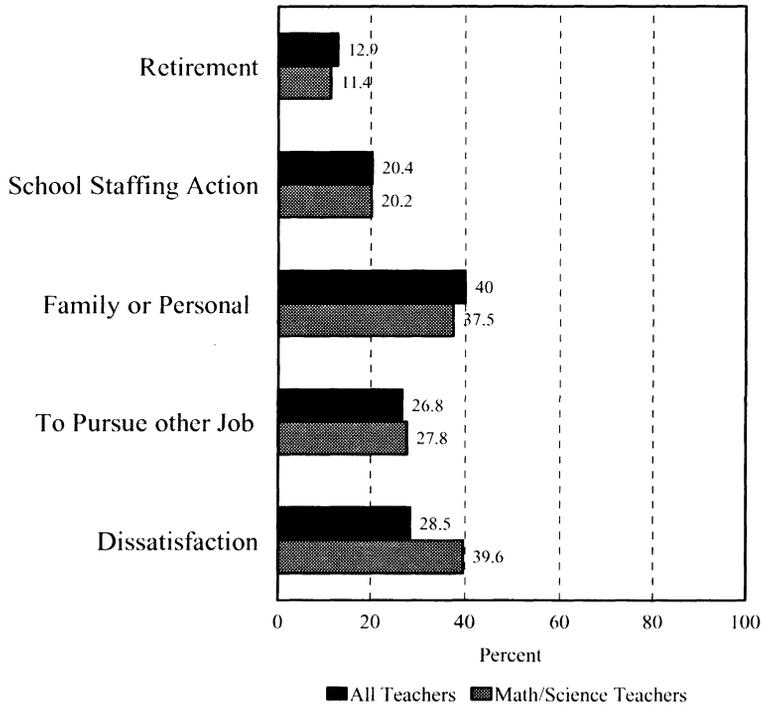


Figure 4. Percent teachers—various reasons for turnover.

The reasons for job dissatisfaction were further analyzed and broken down into categories. Among the most frequent reasons for job dissatisfaction are poor salary, poor administrative support, student discipline problems, lack of faculty influence, and poor student motivation. Poor salaries and administrative support were top among these (see Figure 5 [4]).

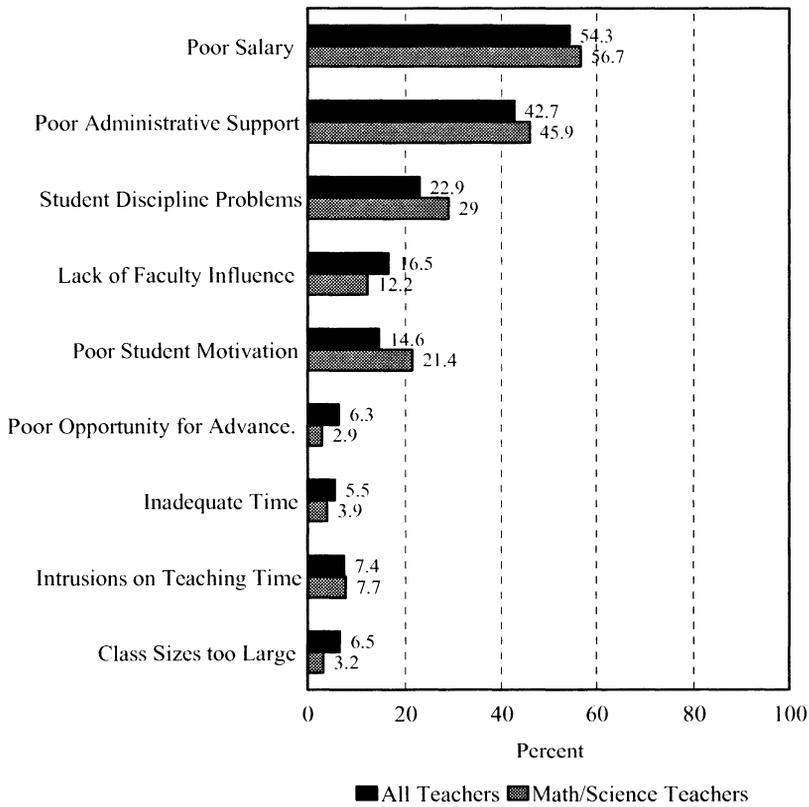


Figure 5. Percent teachers—various reasons for dissatisfaction-related turnover.

Implications of Turnover

Research suggests the teacher shortage is far more complex than the increasing number of students and the increasing retirement of teachers [4]. Since the early 1980s, the quantity of teachers needed is greater than the quantity of teachers available thus causing a teacher shortage [3]. Recruitment alone will not solve staffing inadequacies. Schools must address the problem of teacher retention. The current school environment results in a large numbers of teachers departing for reasons other than retirement. Job dissatisfaction resulting from low salaries, poor administrative support, and student discipline problems are among the leading reasons cited by teachers for leaving. To lower the teacher turnover rate, there needs to be a significant change in the management and conditions of schools.

How Teaching Matters

Since student achievement is the primary focus of schools, looking at the teacher factors that relate to student achievement provides insight into teacher professional development and support. The Educational Testing Service found in its study, *How Teaching Matters*, that increased academic performance of students is linked most closely with classroom practices, followed by professional development of teachers, and then by teacher characteristics such as education level and years of experience [10]. The study examined data from the 1996 National Assessment of Educational Progress test for over 7,000 eighth grade mathematics students and over 7,500 eighth grade science students.

Classroom Practice

The Wenglinsky study found that though subject matter knowledge of the teachers makes a difference in influencing student achievement, classroom practices make an even greater difference in their student achievement. When teachers are skilled at implementing hands-on experiences in the classroom, student achievement increased by 40% of a grade level in science and 72% in mathematics. Furthermore, student achievement increased by 44% of a grade level in science when students had teachers trained in laboratory skills, and by 92% in science and 46% in mathematics when teachers frequently gave specific tests of student understanding, not portfolio-type assessments. The research dispels the idea that only increasing subject matter knowledge of the teachers is needed to help students learn more. In fact, the research from the *How Teaching Matters* report clearly indicates a stronger connection with teacher classroom practice and student achievement [10].

Professional Development

The Wenglinsky study also found that some types of professional development increase student achievement. When teachers receive professional development in higher-order thinking skills, their students increased their performance by 40% of a grade level in mathematics. When science teachers received professional development in laboratory skills, their students' performance increased by 44% of a grade level. Additionally, student performance increased by 107% of a grade level in mathematics when teachers received professional development in working with different student populations.

Teacher Inputs

According to the Wenglinsky study, *How Teaching Matters*, student achievement increased by 39% of a grade level in science and mathematics when their teachers had a major or minor in the subject matter they were teaching [10]. Clearly, the subject matter knowledge of teachers makes a difference in student achievement. However, classroom teaching practices by the teacher makes an even greater difference.

Teacher Preparation

Since research indicates that well-prepared teachers are more likely to remain in the profession, the initial preparation and support of teachers as they enter teaching is critical to them surviving the beginning years of teaching and remaining in the profession [3,9]. Additionally, research indicates that well-prepared teachers have the largest impact on high student achievement [3,11,12].

The teacher retention rate drops sharply over the first five years of teaching, but drops even more sharply for those teachers with little initial teacher preparation (see Figure 6) [3,4]. After three years in teaching, 84% of teachers who entered teaching after completing a bachelor's degree in their subject area and a master's degree in education remained in teaching as compared to 53% who completed a four-year bachelor's program in teacher preparation, and 34% who had only a bachelor's degree in their subject area [3]. In other words, 66% of the teachers with a bachelor's degree in their subject area and little or no teacher preparation before entering the classroom leave the profession by the end of their third year of teaching. It is this group of teachers that is increasingly being hired to fill vacant teaching positions caused by the teacher

shortage. This research clearly indicates the importance of teacher education in helping teachers remain in the profession.

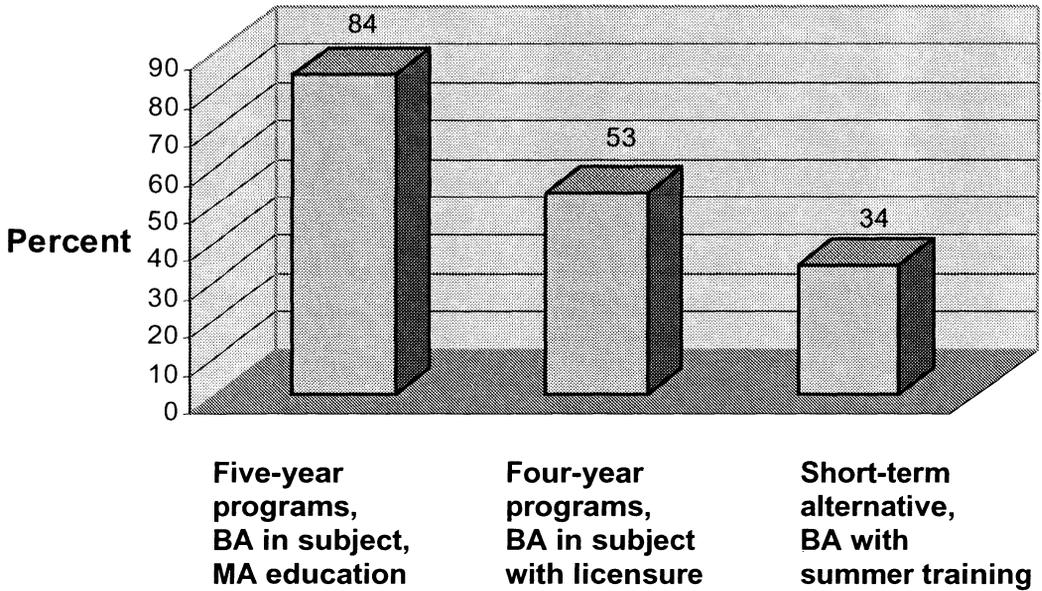


Figure 6. Average retention rates for teachers who remain in teaching after three years.

Recommendations for the Future

To mitigate the spiraling disparity in the need for and availability of qualified science teachers, new systems to recruit, support, and retain teachers need to be developed. Recruiting new teachers is an ongoing problem that is not being remedied by placing unqualified teachers in the classroom on their own to discover how to teach, because these teachers are not remaining in the profession. This costs the school systems valuable time and money to constantly recruit and support new teachers.

Since job dissatisfaction is high among teachers, supportive school environments need to be created where teachers feel that administrators support them and that their opinions influence

decision making. Dedicated and stable teaching staffs will influence student attitudes and motivation.

Since teacher preparation is linked to both retention and student achievement, it is key to provide teachers with strong initial preparation to prepare them for teaching and ongoing support as they enter the classroom. As the need to hire unqualified teachers increases, optimal teacher preparation is not always possible. Therefore, when teachers are hired with little or no teacher preparation, it is especially important to provide them with ongoing support during the first several years as they enter the classroom.

As indicated by research, it is important to bring classroom practice back into discussions of teacher quality. To improve teacher quality that will in turn improve student achievement, policy makers need to find ways to encourage effective classroom practices. According to Wenglinsky, “What really matters is not where teachers come from, but what they do in the classroom.” [10] They will do a better job of teaching if they know what research suggests will work, and have support in developing the strategies to teach.

Identifying what kind of support is most helpful for new teachers leads to the need for research to answer questions, such as: Which support systems work the best to enable beginning teachers to develop the skills and confidence necessary for successful classroom management and quality teaching to enable all students to achieve high standards in science? How can one generation of teachers pass on professional experience and knowledge to the next to enable beginning science teachers to develop professional teaching knowledge and skills? Teachers who begin their pedagogical training prior to entering teaching are more likely to experience success and professional growth in the classroom and to stay in the profession [1]. Research-based, data driven decision making will go a long way toward helping school leaders and policy makers efficiently solve the teacher recruitment and retention problems facing today’s schools. ■

References

- [1] *Before It’s Too Late*, National Commission on Mathematics and Science Teaching for the 21st Century, U.S. Department of Education, 2000, Internet: <http://www.ed.gov/americacounts/glenn>.

- [2] *Journeys Through the Teacher Pipeline: Recaptializing American Education*, U.S. Commission on National Security/21st Century, Washington, DC, 2001.
- [3] L. Darling-Hammond, "Keeping Good Teachers: Why It Matters, What Leaders Can Do," *Educational Leadership*, **60**(8) (2003) 6-13.
- [4] R. Ingersoll, *Turnover Among Mathematics and Science Teachers in the U.S.*, National Commission on Mathematics and Science Teaching for the 21st Century, 2000, Internet: <http://www.ed.gov/inits/Math/glenn/Ingersollp.doc>
- [5] *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, NCES 97[198], U.S. Department of Education, Washington, DC, 1996.
- [6] *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, NCES 97[255], U.S. Department of Education, Washington, DC, 1997.
- [7] *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, NCES 98[049], U.S. Department of Education, Washington, DC, 1998.
- [8] *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999*, NCES 2001[028], U.S. Department of Education, Washington, DC, 2000.
- [9] R. Ingersoll, *Teacher Turnover, Teacher Shortages, and the Organization of Schools*, 2001, Internet: <http://depts.washington.edu/ctpmail/PDFs/Turnover-Ing-01-2001.pdf>
- [10] H. Wenglinsky, *How Teaching Matters: Bringing the Classroom Back into Discussions of Teacher Quality*, Educational Testing Service, Princeton, NJ, 2000, Internet: <http://www.ets.org/research/pic/teamat.pdf>
- [11] L. Darling-Hammond, *Teacher Quality and Student Achievement: A Review of State Policy Evidence*, Center for the Study of Teaching and Policy, University of Washington, Seattle, WA, 1999, Internet: http://depts.washington.edu/ctpmail/PDFs/LDH_1999.pdf.
- [12] L. Darling-Hammond, "Teacher Quality and Student Achievement: A Review of State Policy Evidence," *Education Policy Analysis Archives* **8**(1) (2000).