THE CURRENT STATE AND OUTCOMES OF BASIC SCIENCES EDUCATION IN TÜRKİYE

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Abstract

Curiosity about the natural world around us drives a deeper understanding of life and fosters new advancements through basic sciences. With the announcement of the International Year of Basic Science for Sustainable Development, the crucial role of basic sciences in our lives has been increasingly emphasized, highlighting its impact on basic human needs, the economy, and social and environmental benefits. In this chapter, the education of individuals in basic sciences, from secondary to tertiary levels, and its effects on international exams and employment have been examined in the Turkish context. It has been concluded that up-to-date, hands-on experiments, technology-integrated lesson plans with real-life examples, and role models are needed throughout education. Additionally, multidisciplinary strategies and collaborative, supported projects/activities are essential to meet 21st-century skills. The performance of Turkish students in international exams has been shown to be below the OECD average. Despite a recent increase in student demand for basic sciences, supported by government initiatives, challenges in securing employment in high-skill sectors remain significant obstacles for individuals.

Keywords

Basic sciences, Science education, Tertiary level education, Employment, Skill mismatch

Introduction

The United Nations (UN) General Assembly declared 2022 the International Year of Basic Sciences for Sustainable Development (IYBSSD) on 2 December 2021. While UNESCO organized the opening ceremony of IYBSSD in Paris on 8 July 2023, CERN hosted the closing ceremony in Geneva on 15 December 2023. During this international and comprehensive organization, the main objective was to highlight and raise awareness of the link between the basic sciences and the UN's sustainable development goals. In addition IYBSSD also provided opportunities to give due credit and value to the basic sciences that have allowed us to make sense of the planet and to unlock the potential of the basic sciences to transform our world for the better.

Even though our universe is enormous and complicated, basic science satisfies our curiosity and drives us to understand the fundamental concepts of the natural world. Investigating the underlying principles and processes that govern the universe, this field of science lays the foundation for future developments in the applied sciences and technologies beyond the national boundaries and cultural barriers.

We cannot overstate the importance of basic science since it establishes the basis for development and innovation throughout many disciplines such as applied science, engineering, health, philosophy, and education. The research findings from the basic science studies result with advantageous applications and technical breakthroughs (Adams & Clemmons, 2008; Malva et al., 2015; March & Smith, 1995; Şen, 2022). Technological developments in disciplines such as biology, chemistry, and physics have produced a number of innovations, including medical procedures, communication tools, and renewable energy sources. While conducting basic research, scientists frequently work on challenging and complicated problems, so they require thinking differently and breaking the boundaries across multiple fields. A curious, critical thinking, and problem-solving mindset which are essential to overcome a variety of challenges can be promoted by basic science. Basic science provides the foundation for evidence-based decision-making which is derived by the science process skills (Bell & Lederman, 2003; Şimşek & Kabapınar, 2010). In order to handle global challenges such as resource management, public health emergencies, and climate crisis, policymakers rely on scientific understanding and transform the skills to the applications. The research in basic science and the sharing of knowledge play a crucial role in cultivating a culture of scientific inquiry and discovery. It generates a society that values inquisitiveness, versatile examination, and lifelong learning as well as upcoming generations of scientists.

The researches have shown that only two targets of two different goals in 17 Sustainable Development Goals meet the substantial progress/on track level (Malekpour et al., 2023). These two targets are "increase access to mobile networks" and "increase internet use". Moreover, the estimations on 2030 have indicated that only three targets of different goals can reach the level of on track. One of these targets is "Increase research-and-development spending" which also highly affects the educational focus and the status of the countries, and vice versa. The knowledge transform from university to industry is a key factor in the research-and-development associated activities which are fed by the natural science and engineering studies (Landry et al., 2007).

In the industrial sector, basic sciences form the foundation of human knowledge, driving creativity, technological advancements, and enriching society as a whole (Adams & Clemmons, 2008; Schlagwein, 2021). Without adequate attention to basic science, it is impossible for a country to excel on the international stage. It is widely recognized that the success behind technological and industrial advancements relies on investments in and the development of basic science, as seen in countries such as the United States, the United Kingdom, Germany, Russia, South Korea, and China (Yükseköğretim Kurulu, 2022).

For Türkiye, the general trade system, from January 2021 to January 2022, showed an increase in both import and export rates by 17.2% and 54.2%, respectively. The share of imports was 63.2%, while the share of exports was calculated at 93.3% for manufacturing industry products in January 2022. However, the share of high-technology products in these manufacturing industries was just 9.9% for imports and 2.4% for exports (Turkish Statistical Institute, 2022). Given the key role of basic science in the production of value-added, innovative, and high-tech products, incentives and efforts should be increased in these disciplines.

In the context of basic science for sustainable development, this chapter presents the strategies Türkiye has followed in basic science education at both secondary and tertiary levels. Data regarding curricula, student motivation, educator approaches, and environmental opportunities are presented, based on reports published by the Economic Cooperation Organization Educational Institute (ECOEI). ECOEI organized a series of workshops between 2018 and 2023, each focusing on different fields of basic science and education. The reports from these workshops (e.g., Altun et al., 2023; Arıkan, 2018; Mirici et al., 2023; Şen et al., 2023), which involved researchers, teachers, academics, and students, provided valuable insights into current challenges, possible solutions, and best practices for basic science education in Türkiye.

Furthermore, international assessment test results are included as informative indicators of secondary-level education, and statistics on the employment outcomes of individuals with a background in basic science education are detailed.

Secondary School Level Science Education in Türkiye

Overview of Reports by ECO Educational Institute

Various challenges limit effective learning and knowledge retention in middle school basic science education. With no individual courses for physics, biology, and chemistry offered until grade 5, the curriculum needs to be comprehensive, covering basic concepts and models, renowned scientists, conducting experiments, and making inferences. In addition to the insufficient number of laboratories relative to the high number of schools, there are other challenges such as a lack of materials, inadequate physical conditions, and insufficient teacher time for active lab use. One of the major issues, stemming from limited practical learning, is the rapid forgetting of acquired knowledge. To address these challenges, a shift towards hands-on experiences, engaging with experimental tools, and providing proper guidance is crucial to foster a deeper and more lasting understanding. The problems associated with memorization-based learning can be mitigated by emphasizing connections between concepts and using visualization and real-world applications. Additionally, raising awareness about the interdisciplinary nature of basic science, such as the connections between biology, physics, chemistry, and mathematics, can contribute to long-lasting understanding. Furthermore, developing 21st-century skills such as collaboration, communication, problem-solving, critical thinking, and creativity is necessary to enhance curricula and ensure future generations can adapt to technological advancements.

A common curriculum is followed in all schools, despite the existence of different types of high schools. It is essential to consider individual differences among students and school types, ensuring these differences are not overlooked in tailored curricula. Additionally, the Ministry of National Education has conducted significant measurement and evaluation studies at both national and international levels. These studies serve various purposes, aligning with the changes brought by the emphasis on 21st-century skills (Reyhanlıoğlu & Tiryaki, 2021). While they focus on assessing different skills, the current measurement and evaluation processes fail to account for individual differences among students. A more comprehensive approach that monitors students' progress and guides the educational process could be more effective, potentially increasing student motivation and engagement.

Maintaining high levels of student motivation and curiosity is a challenging aspect of the entire education system. The intensive nature of lessons and limited time for content delivery can lead to a loss of student interest. In the 21st century, we are witnessing rapid advancements in technology, which should be integrated into lessons to capture students' interest (Esen et al., 2023). Traditional, uninspiring, and technology-limited lessons, coupled with inadequate practical experiments, diminish student motivation by preventing connections between theoretical knowledge and real-life concepts. Furthermore, the lack of hands-on experiences negatively impacts students' confidence and ability to work with laboratory equipment and chemicals. Like other education systems around the world, Türkiye has started transforming its teaching methods to enhance student learning by redesigning the primary and secondary curricula since 2005-2006 (Alpaydın & Demirli, 2022).

The successful implementation of teaching processes is essential for sustaining continuity in education at all levels. To adapt to alternative teaching methods, teachers need up-to-date knowledge and lesson plans. Seminars, webinars, and training programs are found to be beneficial in this regard. These activities also promote networking, knowledge-sharing, collaboration, and professional growth, while enhancing teaching skills and encouraging innovative teaching methodologies. Collaboration between institutions, particularly with universities, can also be improved through seminars and conferences. Improvements to lesson plans and curricula should incorporate valuable feedback from students. These feedback mechanisms and their implementation ensure a dynamic and responsive educational environment. On the other hand, financial limitations, intense competition, and potential demotivation may prevent teachers from keeping up with innovation in their profession. Therefore, school funding must be managed wisely to support materials and activities that enrich the teaching and learning experience, fostering a more engaging and effective classroom atmosphere. Prioritizing these aspects will provide an environment where the educational community can work collaboratively to overcome challenges, improve teaching practices, and contribute to the holistic development of both teachers and students.

Both students and teachers face challenges such as an intense curriculum, overcrowded classrooms, and a lack of material and moral support. Flexibility and adaptability are also limited due to standardized classroom designs. Traditional desk arrangements are believed to restrict students' development of 21st-century skills by limiting collaboration and communication. Challenges like inadequate course materials for distance learning, limited technological resources, poor textbooks, the absence of teacher guidebooks, insufficient school funding, and a lack of lab equipment hinder effective learning and teaching. However, the increased budget per student and the decreased average number of students per teacher have contributed to a positive school climate, especially in the last 20 years (Özer, 2022).

A collaborative effort is needed to build effective networks, manage dense curricula, and improve classroom and laboratory environments. Promoting flexibility, adopting modern classroom designs, and investing in quality course materials and technological resources are crucial steps toward creating a more advantageous learning environment for both students and educators.

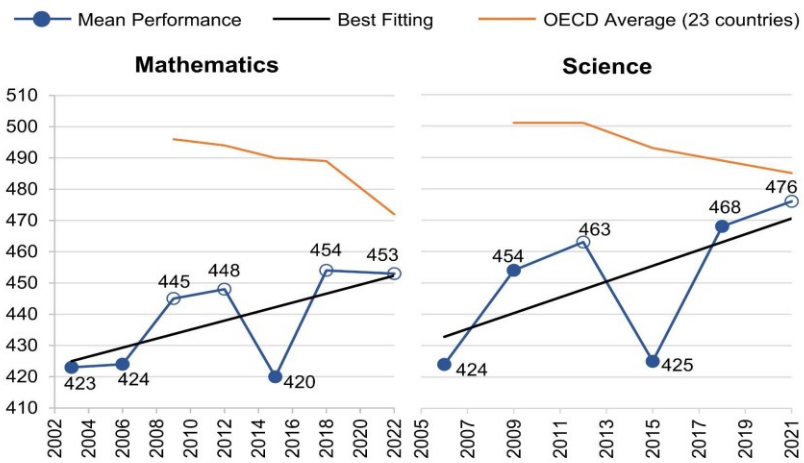
Türkiye's Mathematics & Science Performance in PISA 2022

The results of the Programme for International Student Assessment (PISA), an international assessment test, provide valuable insights into secondary-level basic science education in Türkiye. PISA, last conducted in 2022 with participation from 81 countries, including Türkiye, assessed the knowledge and skills of 15-year-old students in mathematics, reading, and science. The results, released in December 2023, involved approximately 690,000 students globally, including 7,250 students from Türkiye. Overall, the PISA 2022 results indicate a notable decline in student performance across OECD countries, particularly in mathematics. For instance, when compared to the previous assessment in 2018, there was a decrease of nearly 15 points in average mathematics scores across OECD countries (Figure 1).

In the specific case of Türkiye, the average performance in mathematics remained relatively stable between 2018 and 2022, while the average performance in science showed improvement. Despite this increase, Türkiye's science scores have consistently surpassed its mathematics scores in recent years. Moreover, OECD reports have highlighted a significant improvement in Türkiye's PISA performance since 2003 (Özer, 2023).

Figure 1.

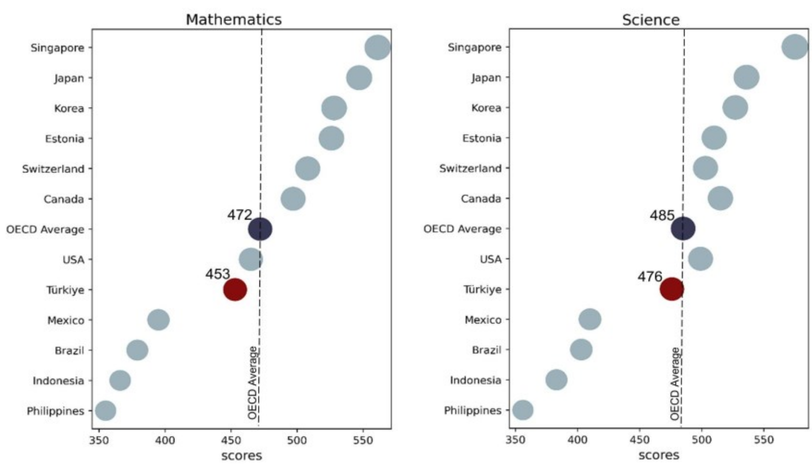
The results of PISA in mathematics and science (OECD, 2023)



As seen in Figure 2, on the other hand, the performance of the Turkish student group in both areas was below the OECD average.

Figure 2.

The top 13 PISA results among the OECD countries (OECD, 2023).



These results indicate that while Türkiye maintained its performance in the latest PISA assessment and even improved in science, it remains below the OECD average in both subjects. For instance, 61% of Turkish students in the 2022 assessment performed at Level 2 in mathematics, which is regarded as the minimum proficiency level expected of 15-year-old students. This is notably lower than the OECD average of 69%. In comparison, countries such as Singapore, Macao, Japan, and Hong Kong saw at least 85% of their students achieve the same proficiency level. Furthermore, while 9% of students across OECD countries reached the highest proficiency levels (Level 5 or 6) in mathematics, only 5% of Turkish students achieved these levels.

In science, 75% of Turkish students achieved Level 2 proficiency, approaching the OECD average of 76%. However, only 4% of Turkish students reached the highest proficiency levels (Level 5 or 6) in science, compared to the OECD average of 7%.

Another notable finding from the 2022 PISA results is the link between preschool education and performance in basic sciences. Only 76% of Turkish students reported having received at least one year of preschool education, significantly below the OECD average of 94%. The data further show that, even when controlling for socioeconomic factors, students from OECD countries who had at least one year of preschool education outperformed their peers who had less than one year or no preschool education, particularly in mathematics.

Tertiary-Level Basic Sciences and Basic Sciences Education Programs in Türkiye

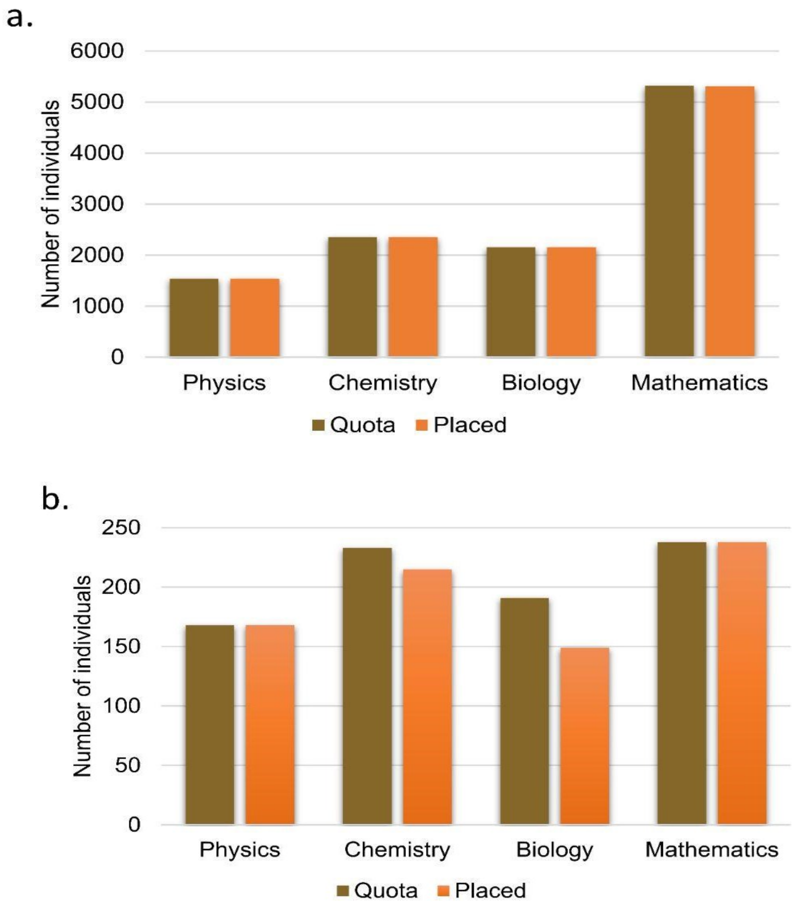
Overview of Reports by ECO Educational Institute

The curricula for basic sciences vary across universities in Türkiye, with each institution employing distinct educational strategies tailored to their specific academic focus. Despite these differences, the general structure of the curricula remains comprehensive, encompassing fundamental knowledge and the core sub-disciplines. For instance, the chemistry curriculum typically includes foundational courses in general chemistry, organic chemistry, physical chemistry, analytical chemistry, biochemistry, and polymer chemistry. However, one of the primary challenges faced by universities is the insufficiency of practical, experiment-based instruction. The limited number of laboratory course hours restricts students' development of practical skills and hinders their ability to learn current techniques. To address this issue, a potential solution involves diversifying the areas covered in experimental courses and incorporating virtual laboratory applications to supplement traditional learning methods. Furthermore, updating experiments and integrating contemporary information into the curriculum is essential to bridge the gap between academia and real-world applications, thus maintaining students' motivation. Internship programs are also valuable for fostering industry collaboration and providing students with practical exposure and real-world insights. While internship periods are incorporated into the curricula, they are often deemed insufficient in duration and diversity. Extending the duration of internships and offering more varied experiences would better prepare students for professional life by allowing them to engage with real-world problems. Additionally, curricula that encourage interdisciplinary experiences through a variety of courses and programs can broaden students' perspectives.

Between 2007 and 2013, annual statistics revealed a significant decline in the average occupancy rate of basic science departments, from 99.13% to 46.38% by 2012. However, in 2013, the average occupancy rate sharply increased to 69.74%. This improvement is attributed to the closure of certain departments and the establishment of new universities, which helped enhance occupancy rates (Gunay et al., 2013). Policy reforms initiated by the Ministry of National Education (MoNE) and the Council of Higher Education (CoHE) have contributed to this trend. As a result, the average occupancy rate in 2022 reached 99.95% (YÖK Meslek Atlası, 2023). According to the 2022 Higher Education Institutions Exam (YKS) statistics, CoHE reported that the mathematics department was the only discipline within the faculty of science where the number of students placed was lower than the total annual quota (Figure 3). In contrast, both the mathematics and physics departments in the faculty of education fulfilled their respective quotas (YÖK Meslek Atlası, 2023).

Figure 3.

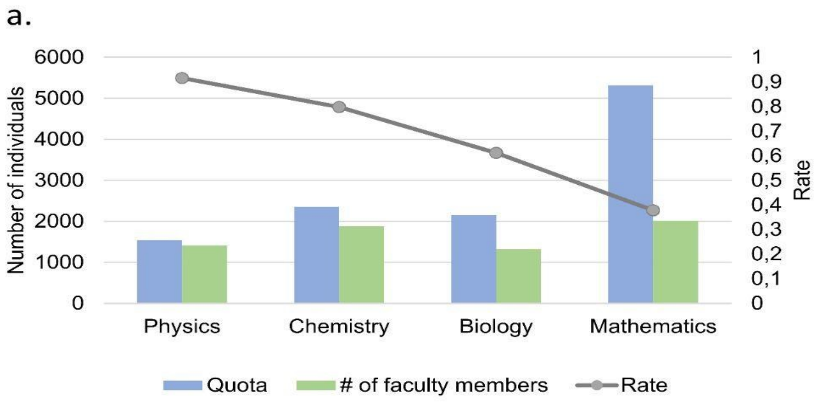
*The visualization of quota and number of placed students in **a.** faculty of science and **b.** faculty of education.*

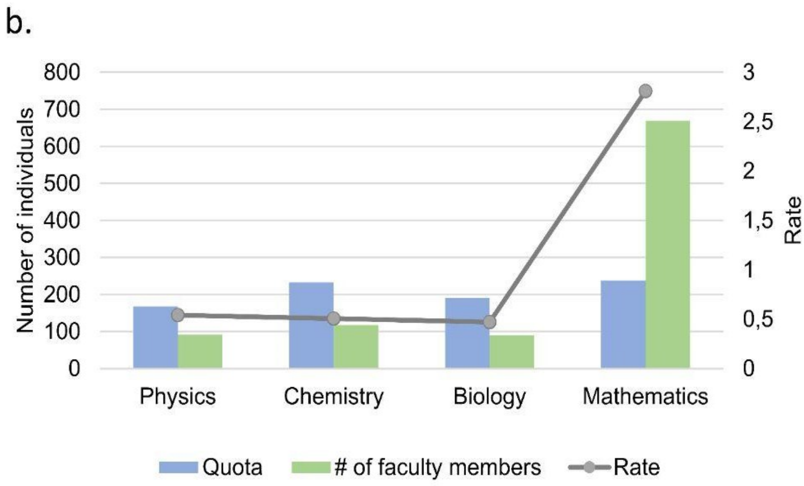


CoHE provided data on the total number of faculty members across various departments. In mathematics, the number of faculty members was higher compared to other basic science disciplines (Figure 4), while the lowest number of faculty members was observed in biology departments. However, the faculty-to-student ratio is much lower in mathematics compared to the other disciplines, with ratios of 0.91, 0.79, 0.61, and 0.37 for physics, chemistry, biology, and mathematics, respectively. In contrast, the education departments demonstrated even lower ratios, except for the mathematics education department. The ratios were 0.54 for physics, 0.50 for chemistry, 0.47 for biology, and 2.81 for mathematics in the education faculties. Developing a rich and diverse academic environment can be achieved through collaboration between faculties, which is essential to enhancing the effectiveness of training across all departments. Increasing cooperation and interdisciplinary engagement among faculty members could significantly contribute to the overall growth and success of both the basic science and education departments. Addressing these issues is critical for optimizing the potential of academic institutions and ensuring a well-rounded and thriving educational experience.

Figure 4.

*The distribution of the number of students and faculty members in **a.** basic science departments and **b.** education departments.*





Similar challenges are faced at universities and high schools, where outdated lecture content, uninspiring lesson design, and a lack of hands-on experimentation result in decreased student motivation. Additionally, traditional experiment report formats limit students' ability to develop individualized approaches to research, design, and presentation of findings. The situation is further exacerbated by the lack of technological integration, which diminishes student interest even more. To address these concerns, modernizing teaching methods, encouraging student autonomy, and incorporating technology to create dynamic and engaging learning environments are transformative strategies that should be implemented. Training programs, conferences, workshops, and seminars are also essential resources for keeping both instructors and students up to date with the latest developments in their fields.

Moreover, insufficient collaboration between institutions, particularly between universities and industry organizations, presents a significant challenge. This lack of synergy restricts the exchange of knowledge and resources crucial for academic and practical advancements. Establishing collaborations with departments and institutes at national and international levels can also enhance student motivation by involving them in current developments. Furthermore, outdated and limited laboratory facilities hinder students from developing the practical skills essential for both academic and professional growth.

Addressing the issue of outdated laboratories and classrooms requires a comprehensive approach to modernization, integrating the latest technological advancements. While universities typically have higher budgets compared to middle and high schools, these resources must be strategically allocated to ensure the provision of essential devices, technological equipment, chemicals, and other course-related materials. Such targeted investment is crucial for creating a conducive and up-to-date educational environment that fosters innovation and prepares students to meet the demands of the modern world.

Additionally, aging infrastructure in older university buildings poses several technical challenges, such as power outages, water leaks, and inadequate temperature control. These issues not only disrupt lectures and laboratory sessions but also negatively affect student motivation and the overall sustainability of the educational experience. To enhance the effectiveness of education, learning environments that prioritize student-centered activities may be more successful in capturing and sustaining student interest. Curricula that incorporate a greater number of hands-on experiences, modern experiments, collaborative programs, and technology-assisted approaches are essential for fostering significant advancements in learning outcomes. By addressing these elements, basic science education can evolve to meet the needs of both students and the ever-changing landscape of scientific progress.

Uni-Veri Data

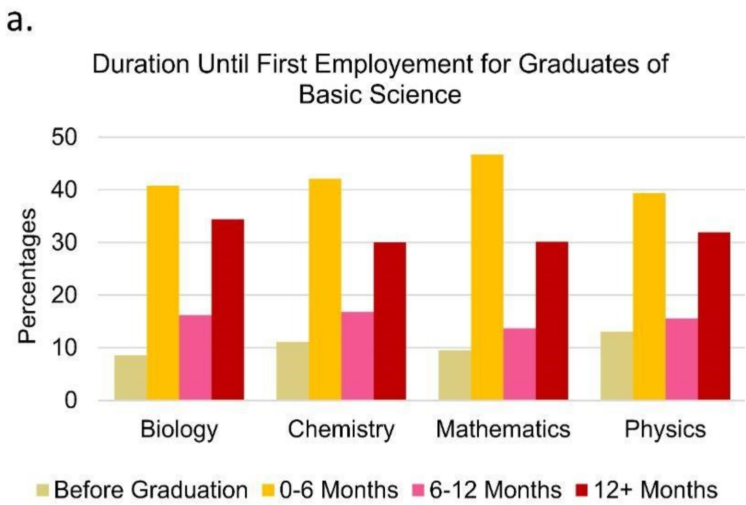
Uni-Veri, an online database provided by the Presidency of the Republic of Türkiye Human Resources Office, is an outcome of a national research project aimed at providing up-to-date data on labor market profiles and the conditions of tertiary-level graduates across different disciplines. This section draws on data from the Uni-Veri platform to compare graduates of basic sciences and basic sciences education programs across several dimensions, including: (i) duration until first employment, (ii) skill mismatch, and (iii) sectoral distribution of graduates.

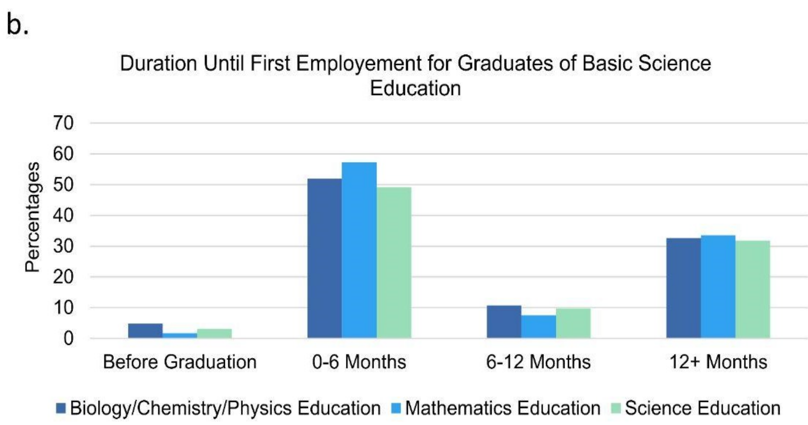
To begin with, the duration and reasons for unemployment, as well as the time it takes for young graduates to secure their first employment, depend on a variety of factors. While some of these factors are related to a country's level of socio-political and economic development, individual factors such as age, gender, marital status, level of education, and relevant work experience also significantly influence employment outcomes (Çağlar et al., 2015).

The graphs presented below highlight the time to first employment for graduates of basic sciences programs and basic sciences education programs across four separate time intervals (Figure 5). For graduates of basic sciences, the proportion of first employment before graduation is the lowest across all time periods, whereas the share of graduates securing employment within the first six months post-graduation is significantly higher, with mathematics graduates leading at 46.7%. A similar trend is observed for graduates of basic sciences education programs. In these fields—biology/chemistry/physics education, mathematics education, and science education—the share of first employment before graduation remains the lowest, while the share of graduates securing a job within the first six months after graduation is consistently the highest.

Figure 5.

*Duration for the first employment of graduates from **a.** basic science and **b.** basic science education departments. Adapted from (UniVeri, 2023).*



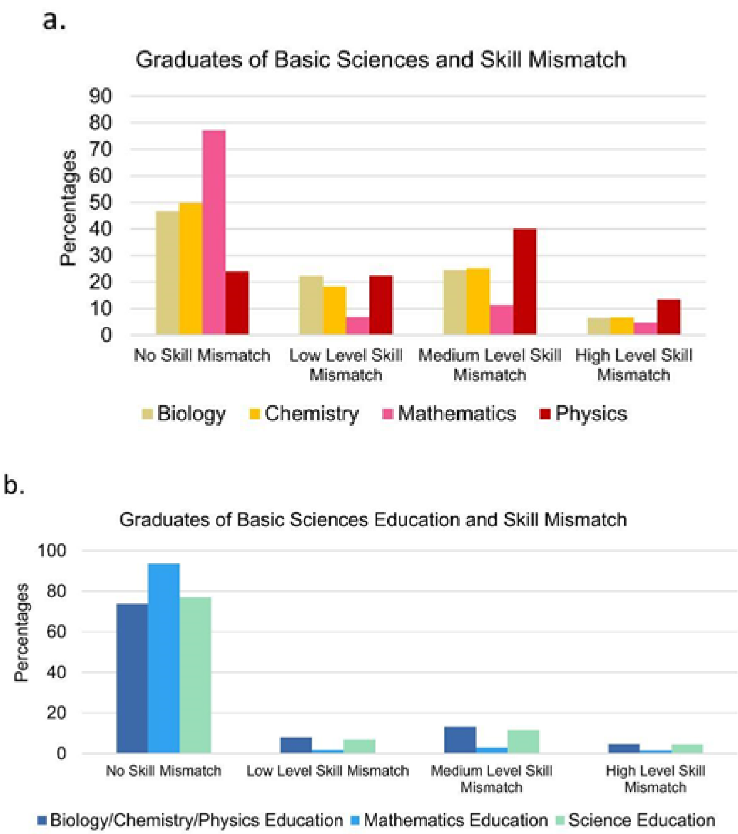


Notably, mathematics and mathematics education graduates exhibit the highest percentages of employment within the first six months following graduation, with 46.7% and 57.3%, respectively. However, the proportion of mathematics education graduates securing employment during this time is clearly higher than that of mathematics graduates.

Skills mismatch occurs when employees' qualifications either exceed or fall short of the demands of their jobs (Handel, 2003). Employees who possess more skills than required are considered over-skilled, while those lacking the necessary skills for their role are under-skilled. Despite the low correlation between over-education and over-skilling (Sloane, 2014), it is fair to suggest that tertiary education has a strong potential to provide specialized skills (Van Damme, 2022).

The graph provided illustrates that among undergraduate programs in basic sciences, the highest proportion of graduates who believe their jobs align with their skills is found among mathematics graduates, while physics graduates report the lowest alignment (Figure 6). Furthermore, physics graduates are more likely to report experiencing a quality mismatch across all levels (low, medium, high), whereas mathematics graduates are the least likely.

Figure 6.
*Skill mismatch for the graduates of **a.** basic science and **b.** basic science education departments. Adapted from (UniVeri, 2023).*



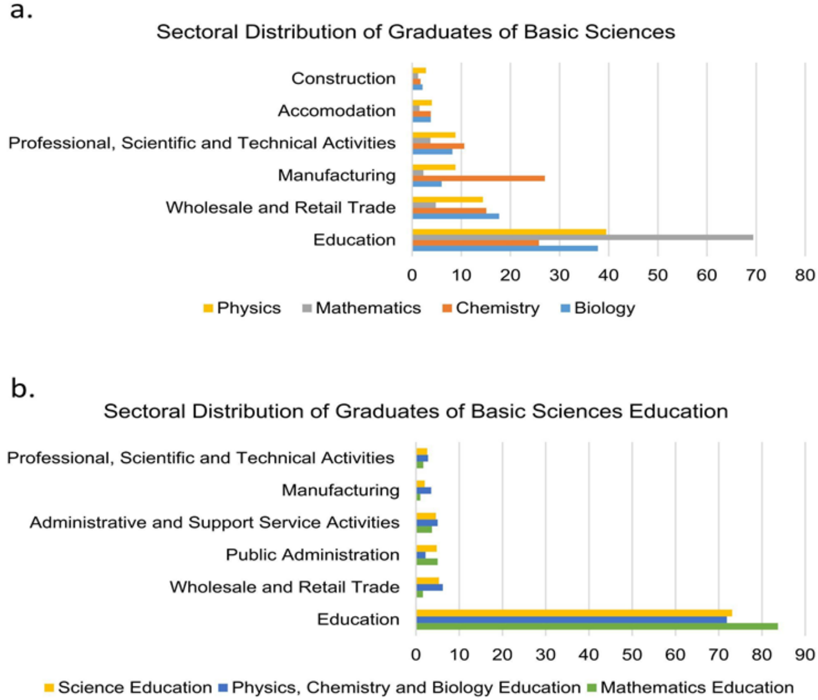
Both mathematics and mathematics education programs stand out for having a high degree of skill overlap between what graduates learned during their education and what their current jobs require. This is particularly pronounced for mathematics education graduates, of whom 93.6% report no skill mismatch. On the other hand, graduates from all fields of basic sciences education report a higher rate of job-skill alignment compared to their counterparts in basic sciences programs. This suggests that basic sciences education graduates generally experience less skills mismatch than basic sciences graduates.

While both basic sciences and basic sciences education graduates share certain employment sectors after graduation, basic sciences graduates also work in fields such as construction and accommodation, sectors less common among education graduates (Figure 7). Conversely, graduates of basic sciences education programs are more frequently found in public administration and administrative and support service sectors.

Figure 7.

Distribution of employment sectors for graduates of ***a.*** *basic science and* ***b.*** *basic science education departments. Adapted from (UniVeri, 2023).*

a.



As expected, the majority of basic sciences education graduates work in the education sector, with mathematics education graduates leading in this area. Similarly, a considerable proportion of basic sciences graduates also work in education, with mathematics graduates showing a particular preference for this sector. In contrast, chemistry graduates are predominantly employed in the manufacturing sector, which aligns with the chemical processes central to the discipline's academic and practical focus.

Discussion, Suggestions and Conclusion

Based on the review, several key issues and recommendations can be drawn regarding the current and future state of basic sciences and basic sciences education in Türkiye.

One notable initiative is the CoHE's Undergraduate Support Scholarship, designed to increase student enrollment in basic sciences programs. However, this can also be viewed as an attempt to fill program quotas rather than addressing the root of the demand for these fields. It remains unclear whether students choose these programs out of genuine interest or due to external motivators like scholarships. Even with filled quotas, employment challenges persist for basic sciences graduates, who often find themselves working in positions unrelated to their field of study. A large portion of basic sciences graduates, for example, are employed in the education sector, just like those from basic sciences education programs. This trend suggests a broader issue: many basic sciences graduates may turn to teaching not out of choice but due to limited job opportunities in their fields, coupled with difficult working conditions (Öztürk Akar, 2014). Additionally, family influence plays a significant role in career choices, as families often steer graduates toward teaching, a profession perceived as stable and familiar (Öztürk Akar, 2014). This dynamic further underscores the need for targeted career guidance for students in basic sciences programs, so they can make informed decisions about their futures.

The practice of directing basic sciences graduates toward pedagogical formation programs to increase employability exacerbates the issue by contributing to an already competitive job market for education graduates. Instead, integrating mandatory internships within the basic sciences curriculum, similar to those in education programs, could offer a more effective solution. These internships would provide students with hands-on experience, helping them better understand their competencies, interests, and potential career paths before they graduate.

Another suggestion is to provide double major or minor program options for students with high academic performance, offering a more comprehensive route into teaching. This would be a more integrated approach compared to the current certificate programs, and it would ensure that graduates entering the teaching profession have a well-rounded education. This could also reduce the number of graduates becoming teachers by default, while enhancing the quality of those who do pursue teaching careers.

It is also essential to develop policies that increase the employability of new graduates across all fields. Increasing the quality, rather than the quantity, of programs is a priority. For example, the 2008 policy to eliminate the requirement for universities to maintain both a Faculty of Science and a Faculty of Letters was a step in the right direction, reflecting the need for adaptable, efficient structures in higher education.

Additionally, insights from the PISA 2022 results emphasize the importance of early childhood education in boosting academic performance, particularly in mathematics. While 94% of students in OECD countries who took the PISA test had attended preschool for at least one year, this figure was only 76% for students in Türkiye. Expanding access to quality preschool education could significantly enhance students' future success in basic sciences, as early exposure to structured learning environments is linked to better academic outcomes.

Frequent curriculum changes in undergraduate basic sciences programs over the last three decades have posed challenges, as there has been insufficient time to assess the long-term impact and effectiveness of these updates. Such rapid modifications can waste valuable resources, including time and budget, and diminish the overall effectiveness of the programs. To avoid this, future curriculum reforms should be innovative, genuinely empowering, and aligned with local and national needs, ensuring that changes are meaningful and sustainable.

A more holistic approach to basic sciences education is needed, one that takes into account interdisciplinary connections and the emergence of new sub-disciplines. The integration of basic science disciplines with one another has given rise to specialized fields that reflect the growing complexity of science in today's world. To fully appreciate the relevance of basic sciences, educators and policymakers must embrace this interdisciplinary perspective, ensuring that graduates are equipped with the skills and knowledge to navigate an increasingly interconnected scientific landscape. Addressing the challenges facing basic sciences and basic sciences education in Türkiye requires a multi-faceted approach. This includes improving employment outcomes, rethinking curriculum changes, expanding early education access, and fostering interdisciplinary collaboration. By doing so, the field can better meet the needs of students and the evolving demands of the scientific community.

The key issue in basic science education at the secondary school level is the need to show students how basic sciences are interconnected with other disciplines and relevant to daily life. Adopting an interdisciplinary approach can increase student motivation and improve their attitudes toward science, leading to higher academic achievement. For teachers, curriculum developers, and textbook authors, emphasizing these connections would foster a deeper interest in basic sciences, making the subjects more appealing and accessible.

Science high schools in Türkiye, such as the TÜBİTAK Science High School, accept students with the highest academic achievement, providing advanced education in mathematics and science. However, data from 2011 to 2019 shows that the majority of graduates prefer medicine and engineering over basic sciences (Suna et al., 2020). This preference is influenced by factors such as job market conditions, ease of employment, program prestige, and guidance from parents and teachers (Kurt & Fidan, 2021; Suna et al., 2021). To counter this trend, policies that create better job prospects for basic science graduates should be developed. Additionally, efforts should be made to raise awareness among parents and teachers about the importance and opportunities in basic sciences.

TÜBA's reports highlight the need to improve the quality of doctoral education and increase the number of doctoral graduates to support Türkiye's research and development efforts. While increasing the number of PhD graduates is important, the problem cannot be resolved solely through this measure. Well-planned employment policies are essential to ensure PhD graduates find suitable academic positions, particularly in faculties of science and education, where student-to-teacher ratios are often too high. Better planning in this area could help alleviate this issue by reducing the workload on faculty members and improving the overall quality of education.

In Türkiye, students must take the Core Proficiency Test (TYT) and the Advanced Proficiency Test (AYT) to gain university admission. However, the representation of basic sciences in these tests is both inadequate and limited in scope. Physics, chemistry, and biology are underrepresented, which affects the content validity of these tests. This has a backwash effect on the teaching and learning of basic sciences in secondary schools, as teachers and students may prioritize topics that are likely to appear on the exams, leaving out important areas of study. This weak alignment between testing and comprehensive subject learning negatively impacts students' motivation and engagement with basic sciences.

Improving basic science education requires collaboration between academic institutions, reducing the workload of extensive courses, and upgrading laboratory and learning environments. Collaborative efforts between disciplines and institutions should focus on implementing contemporary teaching strategies and allocating resources for advanced technology in education. Flexibility in course design and content delivery is crucial for creating a more effective educational environment.

Technology-assisted approaches, hands-on experiences, and student-centered activities can enhance the relevance of basic sciences in today's rapidly changing scientific landscape. Science high schools, particularly those like TÜBİTAK Science High School, with their modern technologies, advanced science workshops, and five-year programs, hold significant promise for the future of basic sciences education.

In conclusion, to strengthen basic sciences in Türkiye, a holistic approach is needed, encompassing curriculum reform, early engagement in interdisciplinary learning, and policies that improve the employability of graduates. High-stakes testing must better reflect the breadth of scientific knowledge, and the alignment between secondary education and university entrance exams should be improved. Science high schools must continue to evolve, and investment in modern teaching practices and technology will be key in shaping the future of basic sciences education in Türkiye. Finally, increasing awareness among parents, teachers, and policymakers about the value of basic sciences will be critical for creating a more supportive environment for students to pursue careers in these fields.

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