The Effect of Human Capital as an Output of Education on Productivity: A Panel Data Analysis for Developing Countries

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Abstract

In the rapidly changing atmosphere of the global economy, productivity has become a very important concept for long-term economic growth, development, regional and global competitiveness, raising social living standards and increasing the level of welfare for countries. In the 21st century, when scientific knowledge, technology, innovation, R&D and entrepreneurship manifest themselves in every stage of the production process, human capital has come to the fore as an important and determining factor that increases productivity. In the current study, the effect of human capital, one of the most important outputs of education, on country productivity was analyzed for 24 developing countries, including Turkey, which are in the upper middle income group. In the application part, a panel data set was created for the 24 countries included in the study with the series obtained from the database of PWT10.0 for the period of 1980-2019. The Human Capital Index was used to reveal the human capital status of the countries included in the analysis and the Total Factor Productivity Index was used to reveal the productivity status. The Granger Panel Causality Test was employed to determine whether there is a short-term relationship and the Westerlund Panel Cointegration Test was employed to determine whether there is a long-term relationship between the two variables. As a result of a bilateral causality relationship was found between human capital and productivity in the short-term and a cointegration relationship in the long-term. The study is important and different from other studies in that it focuses on the concepts of human capital and productivity, which have a very limited place in the education literature, although they are directly related to education, and it is grounded on an interdisciplinary approach (bringing together education, sociology and econometrics).

Keywords: Education, human capital, productivity, developing countries, panel data analysis

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Introduction

In the face of rapid technological developments and changing global dynamics, education has become the driving force of social development, economic growth, global competitiveness, efficiency and productivity by making economic, social, cultural and political conditions suitable. Education acts as a catalyst for the formation of human capital that nurtures knowledge, skills and competencies that drive innovation, productivity and social well-being. Strong and robust educational institutions significantly affect and improve productivity through the human capital they create and by strengthening infrastructure capabilities, building strong institutional structures, especially in education and healthcare, generating new technologies, ensuring the uninterrupted continuity of research and development (R&D) activities, developing innovations, promoting the integration of entrepreneurship into society and its transformation into a culture, creating a working culture and style suitable for the business ecosystem, making production factors functional and enhancing management and leadership skills for firms, industries and economies.

Productivity, in the broadest sense, refers to the difference between the inputs involved in the production process and the outputs generated at the end of the production process. In other words, productivity means trying to achieve maximum output with minimum input by efficiently utilizing the available resources (Aktakas et al., 2014; OECD, 2001; Toprak & Demirkıran, 2022). Productivity, an indicator of the output obtained per unit of input used, is producing more value with fewer resources without compromising quality. Increases in productivity cause costs to decrease, while decreases in productivity cause costs to increase. Given that resources are not unlimited, the importance of developing the right strategies and policies for the effective management of existing insufficient resources becomes evident (Sart, 2018).

Effective management strategies and policies of existing resources from the firm level to the sectoral level, from the sectoral level to the national level, from the national level to the global level are of critical importance for productivity. Innovative product, service, management and marketing types and approaches put forward in this direction lead to more effective management and use of limited resources in all institutions, increasing efficiency and reducing costs (Sart, 2018). Increase in productivity is of great importance in the economic growth and development of countries, in their achieving global competitiveness and in increasing their social living standards and welfare levels (Begeç, 2021; Jajri & İsmail, 2010; Timmer et al., 2011; Wysokińska, 2003). As such, it has become crucial to identify the factors that can increase productivity levels for countries and to implement the right strategies, policies and practices that are appropriate for and responsive to the emerging conditions and needs.

There are many factors affecting the productivity level of a country. They can be listed as follows: (1) accumulation of human capital, (2) level of adoption and utilization of information and communication technologies, (3) efficiency level of research and development activities, (4) level of

innovation, (5) population structure, (6) socio-cultural structure, (7) economic conditions, (8) education system, (9) level of effective functioning of institutional mechanisms, (10) physical infrastructure capabilities, (11) natural resources, (12) work culture and business practices, (13) business ecosystem, model and design, (14) university-industry collaboration, (15) dissemination level of entrepreneurial culture through society, (16) regulations, (17) competitiveness and (18) political environment and governance approaches (Aktakas et al., 2014; Begeç, 2021; Jajri & İsmail, 2010; OECD, 2001; Penekli, 2019; Prokopenko, 1992; Timmer et al., 2011; Toprak & Demirkıran, 2022; Wysokińska, 2003). However, especially in the 21st century, when information, technology, innovation, R&D and entrepreneurship activities have gained importance, the role of human capital as a qualified manpower in productivity growth has been becoming more and more important and decisive.

Although human capital is directly related to education, it has not been adequately addressed in the education literature. The majority of the literature on human capital has been concentrated in the field of economics. Given the rapidly and continuously changing dynamics of the global world, it does not seem prudent to explain and analyze human capital, which emerges as the fundamental driving force behind social progress, development and advancement and whose importance increases with each day and its effects and the outcomes it generates on the basis of a single discipline. On the other hand, although the concept of productivity, which is seen as the key to sustainable growth, development and global competitiveness for today's economies, is related to education, it has not taken its deserved place in the education literature. Most of the studies on productivity are concentrated in the fields of management, finance and economics.

In the current study, the effect of human capital as an output of education on productivity was analyzed for 24 developing countries, including Turkey, which are in the upper middle income group, with an interdisciplinary research approach that brings together education, sociology and econometrics. Granger Panel Causality Test and Westerlund Panel Cointegration Test were used in the application part of the study covering the period of 1980-2019. In light of the findings obtained as a result of the application, some suggestions were made.

Human Capital as an Outcome of Education

In its most general sense, human capital refers to the collective knowledge, skills, abilities, behaviours and health qualities of individuals in a country that contribute to their economic productivity and general well-being (Barro, 1990; Becker, 1994; Begeç, 2021; Berkman, 2008; Romer, 1990; Tunalı & Yılmaz, 2016; Yaylalı & Lebe, 2011). Education serves as a catalyst for acquiring and developing these valuable qualities. In the broadest sense, education is the process of imparting various knowledge, skills, abilities, attitudes and behaviours to individuals, taking into consideration the needs of the individual and society, as well as the conditions of the time. The knowledge, skills, abilities, attitudes and behaviours imparted to individuals in a planned, structured and systematic manner within the education process, according to predetermined objectives, result in qualified, productive, dynamic and

healthy human capital. As an output of education, human capital is a critical factor for the economic growth, competitiveness and social welfare of a country. Education is a powerful tool that helps people develop their skills, think innovatively and realize their potential. A good education system contributes to the general development of society by making people well-equipped, knowledgeable and analytical, critical, reflective and creative thinkers.

Each level of education, from early childhood education to higher education, has a strong influence on the formation and development of human capital. At each level of education, the development of human capital is ensured by imparting various competences (knowledge, skills, attitudes, abilities, behaviours, etc.) to the individual. The general objectives aimed to be imparted to the student/individual at each level of education are presented in Figure 1.
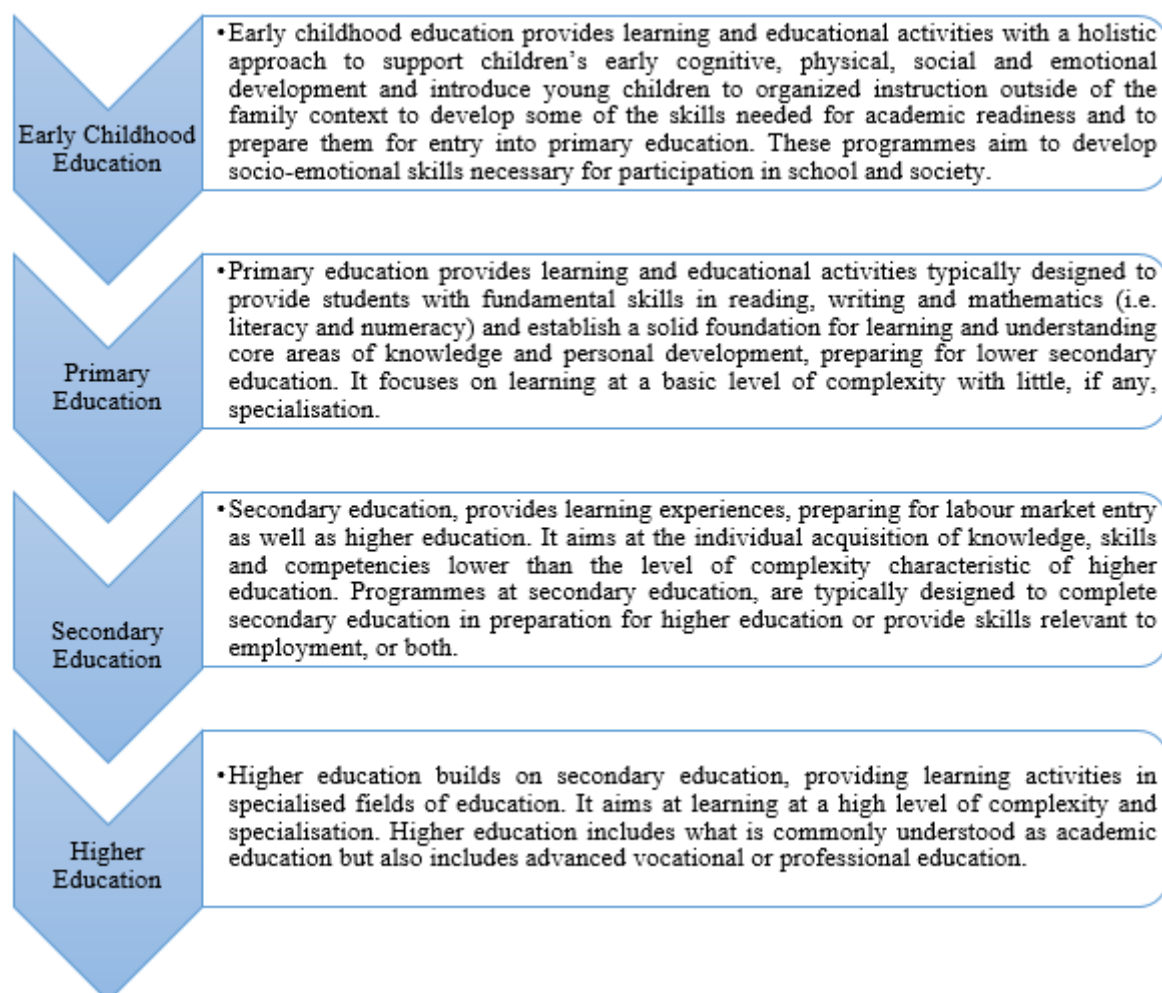
Early Childhood Education
- Early childhood education provides learning and educational activities with a holistic approach to support children's early cognitive, physical, social and emotional development and introduce young children to organized instruction outside of the family context to develop some of the skills needed for academic readiness and to prepare them for entry into primary education. These programmes aim to develop socio-emotional skills necessary for participation in school and society.

Primary Education
- Primary education provides learning and educational activities typically designed to provide students with fundamental skills in reading, writing and mathematics (i.e. literacy and numeracy) and establish a solid foundation for learning and understanding core areas of knowledge and personal development, preparing for lower secondary education. It focuses on learning at a basic level of complexity with little, if any, specialisation.

Secondary Education
- Secondary education, provides learning experiences, preparing for labour market entry as well as higher education. It aims at the individual acquisition of knowledge, skills and competencies lower than the level of complexity characteristic of higher education. Programmes at secondary education, are typically designed to complete secondary education in preparation for higher education or provide skills relevant to employment, or both.

Higher Education
- Higher education builds on secondary education, providing learning activities in specialised fields of education. It aims at learning at a high level of complexity and specialisation. Higher education includes what is commonly understood as academic education but also includes advanced vocational or professional education.

Figure 1. Objectives across the levels of education.
Source: (UNESCO, 2011)

For a qualified and healthy human capital, it is necessary to consider the education levels as a whole. Each level of education forms the basis for the next level. As the level of education advances, the development and specialization of human capital increase. Early childhood education improves

children's cognitive, physical, linguistic and socio-sensory skills and increases their readiness for primary education. Investing in early childhood period provides a strong foundation for the accumulation of human capital by promoting future success in both personal and professional domains. Primary education prepares students for secondary education by equipping them with basic skills for literacy and mathematics. Secondary education develops critical thinking, problem-solving skills and effective communication skills through core disciplines such as mathematics, science and social sciences by providing a broad-based curriculum that nurtures core knowledge and skills. A multi-dimensional secondary education equips individuals with the necessary foundational competences for higher education or the labour market. Higher education assumes an important role in the formation of human capital by offering highly specialized knowledge and advanced skills. Higher education provides a platform for deep learning, research and the development of professional expertise. Equipped with specialist knowledge, graduates contribute to innovation, technological advancement, efficiency, economic growth and competitiveness. It should also be emphasized that it is not only formal education that ensures the formation of human capital in a country. In this context, lifelong learning contributes to the development of human capital by enabling individuals to acquire new knowledge and skills throughout their professional journey.

Various international institutions and organizations such as the World Economic Forum (WEF), Groningen Growth and Development Centre (GGDC), World Bank (WB) and United Nations Development Programme (UNDP) have conducted studies to assess the human capital status of countries and provide opportunities for comparison with other countries worldwide. The current studies prepared by these international institutions and organizations are as follows:

- Global Human Capital Index prepared by WEF (2017a),
- Human Capital Index within the scope of Penn World Table 10.0 (PWT10.0) prepared by GGDC (2019),
- Human Capital Index prepared by WB (2020) and
- Human Development Index prepared by UNDP (2021).

When these studies are examined, it is seen that although there are minor variations in rankings over the years, the countries that generally rank high in human capital index rankings are Sweden, Singapore, Norway, Canada, Finland, Denmark, the United States, the United Kingdom, Germany and Australia. On the other hand, the countries that rank at the bottom are Afghanistan, Pakistan, Nigeria, Iraq, Chad, Zambia, Tajikistan, Algeria, Egypt and Yemen. In this respect, it would be useful to examine Figure 2, which was created to reveal how important education is in the formation of human capital.
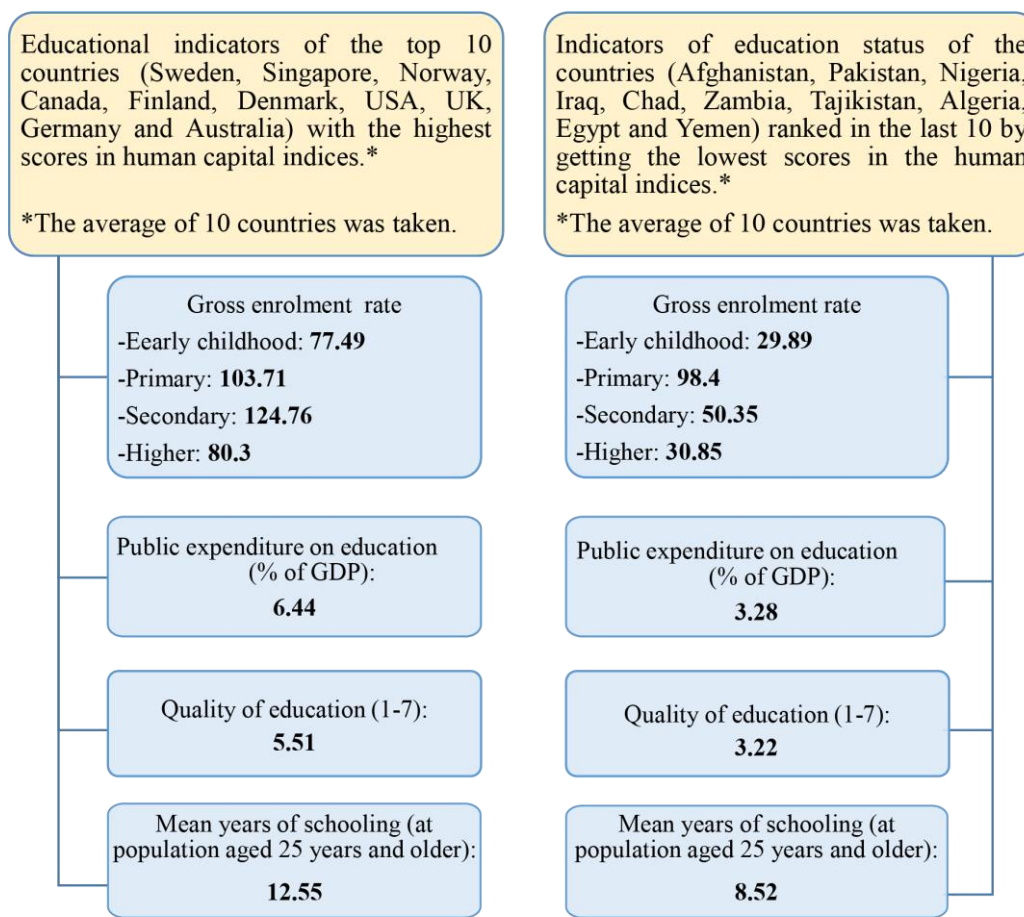
Educational indicators of the top 10 countries (Sweden, Singapore, Norway, Canada, Finland, Denmark, USA, UK, Germany and Australia) with the highest scores in human capital indices.* *The average of 10 countries was taken.	Indicators of education status of the countries (Afghanistan, Pakistan, Nigeria, Iraq, Chad, Zambia, Tajikistan, Algeria, Egypt and Yemen) ranked in the last 10 by getting the lowest scores in the human capital indices.* *The average of 10 countries was taken.
Gross enrolment rate -Eearly childhood: **77.49** -Primary: **103.71** -Secondary: **124.76** -Higher: **80.3**	**Gross enrolment rate** -Early childhood: **29.89** -Primary: **98.4** -Secondary: **50.35** -Higher: **30.85**
Public expenditure on education (% of GDP): **6.44**	**Public expenditure on education (% of GDP):** **3.28**
Quality of education (1-7): **5.51**	**Quality of education (1-7):** **3.22**
Mean years of schooling (at population aged 25 years and older): **12.55**	**Mean years of schooling (at population aged 25 years and older):** **8.52**

Figure 2. Education factor in the formation of human capital (2017).

Source: (UNESCO, 2023; WB, 2023; WEF, 2017b)

As seen in Figure 2, countries with strong education are ranked the highest in human capital. It is also seen that quality human capital emerges more strongly in countries where the enrolment rate is higher at all levels of education from early childhood education to higher education, public expenditures on education are proportionally higher, the quality of education is higher and the average length of stay in education is longer. In short, an education system that is built on strong and solid foundations, considering both quality and quantity principles and operates effectively is the most important source for a qualified, productive, dynamic and healthy human capital, also known as human resources.

Increasing Importance of Human Capital

After the World War II, especially with the effect of technological developments, the development gap between countries widened more. This led to the examination of the factors that contribute to the development of countries. Until the 1960s, when Classical Economic Theories dominated, the main determining factor for the development of countries was thought to be economic growth and development. On the other hand, the main factors of production (natural resources, physical capital, labour based on muscle strength and entrepreneurs) were pointed out as the determining factors in countries' economic growth and development. Studies conducted in the 1960s and later revealed that

these factors were insufficient to explain countries' economic growth and development. The results of many researchers, especially those of Schultz (1960) and Denison (1962), supported this situation. This situation brought the Neo-Classical Growth Theories, which were dominant especially between the years 1960 and 1980, to the fore in the explanation of social and economic conditions.

In the study conducted by Schultz (1960), the reasons for the economic growth experienced in the USA during the period 1900-1957 were tried to be explained. In the study, it was stated that the outputs in the economy were more than the inputs, that this surplus of output could not be explained by traditional production factors such as natural resources/land, physical capital and labour, and that the amount of surplus mentioned could be explained by another production factor that was not sufficiently emphasized so far. Schultz explained 36% to 70% of the amount of surplus in the mentioned economic growth with the production factor, which he expressed as human capital. In the study conducted by Denison (1962), the economic growth experienced in the USA during the period of 1929-1960 and the factors affecting economic growth were tried to be determined. In the study, annual growth was determined as 2.93%. Denison (1962) stated that the traditional factors of production; labour and capital, had a 0.92% effect and human capital had a 2% effect on this growth rate.

In these studies (Schultz, 1960; Denison, 1962), along with the findings regarding the effect of human capital on economic growth, it has been revealed contrary to the previous general assumption that natural resources, physical capital and labour, which are the fundamental production factors, are not sufficient for countries to achieve economic growth, development, and reach the levels of developed countries. The positioning of human capital as a factor of production, which was previously not emphasized enough in the context of economic growth and development, has necessitated the redefinition and reclassification of fundamental production factors. This, in turn, has accelerated studies aimed at understanding the concept of human capital and its impact.

In Neo-Classical Growth Theories that were dominant until the 1980s, many factors sparked debates in the economic literature. These include viewing human capital solely as a production factor (Gökçen, 2006), neglecting productivity changes in human capital (Ercan, 2002), treating technological progress and population growth as exogenous variables, the idea of diminishing returns to capital, the convergence hypothesis claiming that the growth gap between developed and underdeveloped countries would decrease over time (Taban & Kar, 2006) and attaching importance to quantitative growth (Yaylalı & Lebe, 2011). This situation paved the way for the Endogenous Growth Theory, which emerged after the 1980s, to be addressed in the economics literature.

According to the endogenous growth theories that came to the fore with the studies of Romer (1986) and Lucas (1988), economic growth and development emerge endogenously through the interaction of production factors within the economic process (Ercan, 2002; Tunalı & Yılmaz, 2016; Yaylalı & Lebe, 2011). In these theories, contrary to the neoclassical growth theories, it is argued that knowledge and technology generate positive externalities, that each piece of knowledge sets the

foundation for subsequent advancements and that knowledge provides increasing returns in the production process in the long-term. In endogenous growth theories, factors such as human capital (Jones, 1996; Lucas, 1988), technological advancements and R&D activities (Aghion & Howitt, 1992; Grossman & Helpman, 1991; Romer, 1986; Romer, 1990), public investments (Barro, 1990), physical capital investments and learning by doing (D'Autume & Michel, 1993; Rebelo, 1991; Romer, 1986) are emphasized.

Thus, together with endogenous growth theories, knowledge, technology and R&D activities and human capital, which contributes to their formation and development, have come to the fore as fundamental determinants of countries' economic growth and development processes. Moreover, in today's knowledge-based societies, where classical production factors such as physical capital, natural resources and unskilled labour (brute muscle strength) have gradually lost their significance and the importance of knowledge, technology, innovation and R&D activities has increased, the significance of human capital has been better understood with endogenous growth theories.

It is possible to give many examples that will confirm the value that endogenous growth theories ascribe to knowledge, technology, R&D and human capital. Despite having natural resources, physical capital and large labour supply, there are many countries that fall behind in economic growth and development and cannot reach the level of developed countries. If countries' economic growth, development and progress were solely dependent on abundant natural resources and large labour supply, then countries rich in oil like Iraq, Saudi Arabia, and Libya, and countries with a large labour force like China, India, Pakistan and Bangladesh would be the world's richest economies and most developed countries (Berkman, 2008). On the other hand, countries like Japan and Germany, which do not possess natural resources such as oil, would be expected to lag behind in terms of their social and economic conditions. However, these countries have managed to achieve a central position in the world economically and technologically by realizing their growth and development (Seçgin, 2008). It is possible to see the same situation in Asian countries including South Korea, Singapore, Hong Kong, Taiwan and Thailand. Despite their limited natural resources, these countries have rapidly achieved economic growth and development, allowing them to catch up with the levels of developed countries (Becker, 1994).

The common characteristic of countries that have achieved a central position in the international arena by rapidly achieving economic growth and development despite their limited natural resources is the establishment of effective and quality education systems which have contributed to the formation of a strong human capital. These countries have achieved sustainability in economic growth and development by developing a skilled, productive, dynamic and healthy workforce. They have fostered technology and innovation, made research and development activities effective, promoted entrepreneurship and increased productivity and efficiency.

In short, in the ever-evolving global economy, human capital has emerged as the fundamental driving force behind development, progress and advancement. In fact, how important human capital is in economic growth, social development, global competition and productivity is increasing with each day. As stated in the Tenth Development Plan of the Republic of Turkey Ministry of Development; the 21st century will be the century of countries that not only educate qualified human resources but also attract them on a global scale and utilize them effectively, generate new knowledge by harnessing global information, convert knowledge into economic and social benefits, integrate this process with information and communication technologies and embrace a human-centred development approach (Republic of Turkey Ministry of Development, 2013).

The Effect of Human Capital on Productivity

In the rapidly changing atmosphere of the global economy, productivity has become a very important concept for long-term economic growth and development, regional and global competitiveness, raising social living standards and increasing welfare levels (Begeç, 2021; Jajri & İsmail, 2010; Timmer et al., 2011; Wysokińska, 2003). It is not possible to talk about the progress and development of an economy without efficiency and productivity. As such, it has become essential for countries to identify factors that will enhance their productivity levels and implement appropriate strategies, policies and practices that are suitable for the emerging conditions and address the needs accordingly. In the 21st century, characterized by the evident presence of scientific knowledge, technology, innovation, research and development (R&D) and entrepreneurship throughout the production process, human capital has come to the fore as a significant and influential factor to increase productivity.

The effect of human capital on productivity begins with the development of people's knowledge and skills. Businesses can improve the skills of their employees by providing training and development opportunities for their employees on a regular basis. In this way, the productivity of businesses and the quality of their products and services increase. At the same time, better training of employees increases the innovation ability of businesses and fosters the development of new products and services. Thus, productivity in businesses leads to sectoral productivity and sectoral productivity leads to national productivity.

Human capital significantly influences and enhances productivity by generating advanced technologies, fostering innovation, ensuring uninterrupted R&D activities, promoting entrepreneurship as a societal norm, constructing robust institutional structures with a focus on education and healthcare, strengthening infrastructure capabilities, cultivating a work culture and style suitable for the business ecosystem, enabling the effectiveness of production factors, developing management and leadership skills for firms/industries/economies, and devising appropriate strategies and policies that address specific needs.

It is possible to list the ways in which human capital affects productivity in general as follows:

Technology, Innovation and R&D

Human capital affects productivity with its contribution to the development of technology and innovation. Advanced technologies and effective innovations incorporated into the business and production process affect a country's productivity in four fundamentally different ways. The first one is automation. Industrial robots can provide faster and error-free production by replacing human power in production processes. This allows people to focus on more complex and strategic tasks for greater efficiency. The second one is information and data management. Technology helps manage data more effectively with tools including big data analytics, cloud computing and artificial intelligence. Technology helps manage data more effectively with tools including big data analytics, cloud computing and artificial intelligence. This improves the decision-making processes of firms, industries and economies and allows them to use resources more efficiently. The third one is communication and collaboration. Advances in communication technologies facilitate communication and increase collaboration between businesses. Virtual meetings, teleconferences, and other communication tools provide collaboration opportunities independent of time and place. This increases productivity by speeding up business processes. The fourth one is product and service improvements. Innovation is the process in which new and newer products and services are developed. Innovative products offer advantages such as higher quality, lower cost, better performance and more functionality. This makes businesses more competitive and increases productivity. On the other hand, human capital brings continuity and vitality to productivity by introducing new products, services, technologies, innovations, management and marketing approaches that can meet the rapidly changing needs and standards of global markets and by increasing the continuity and functionality of R&D activities.

Entrepreneurship

Another way that human capital affects productivity is entrepreneurship. By engaging in entrepreneurial actions, promoting entrepreneurship and facilitating the integration of entrepreneurship into the social fabric and culture, human capital can enhance productivity by creating a vibrant entrepreneurship ecosystem. Entrepreneurship affects productivity in many different ways. The first one is creativity and innovation. Entrepreneurs often have the ability to think creatively to find new solutions to existing problems. Developing new ideas, producing innovative products and services and facilitating business and market processes increase productivity. The second one is job creation and employment. Entrepreneurs create business opportunities by starting new businesses or expanding existing ones. Increased employment can lead to increased productivity and efficiency in the economy. The third one is resource utilization. Entrepreneurs tend to use limited resources most effectively. When faced with factors such as limited budget, time and human resources, they make strategic decisions to effectively manage these resources and achieve the best results. In short, optimum use of limited resources leads to increased productivity. The fourth one is the flexible working culture.

Entrepreneurship promotes the flexible working culture suitable for the business ecosystem. Such an environment can increase productivity by encouraging individuals to work in ways that suit their strengths and preferences. The fifth one is collaboration and leadership. Entrepreneurs know that they need to develop their leadership skills and collaborate with teams to be successful. Good leadership helps employees unleash their potential and work efficiently. At the same time, collaboration can contribute to the emergence of innovative ideas and solutions by combining different skills and perspectives.

Education and Health

Education and health are the two basic elements that are the source of the formation and development of human capital. The quality and quantity of human capital in a country is parallel to quality and quantity of education and health institutions. The construction of strong and dynamic education and health institutions in a country is only possible with human capital. In short, education and health are in a mutual causality relationship with human capital: They are both the cause and the result of each other. At this point, human capital, whose basic components are education and health, increases productivity by building strong and effective education and health institutions and increasing the general education and health level of the workforce. Education equips individuals with various knowledge, skills and competences. The effect of these gains on productivity depends on the active participation of the individual in the production process. The active participation of the individual in the production process and the ability to reveal his/her full potential depends on his/her health. By building an educated and healthy society, human capital also creates an efficient and productive economy.

Strategy and Policy

With the effect of scientific and technological developments, the rate of change is increasing exponentially. This situation, on one hand, leads to desired outcomes such as increased productivity, social development, economic growth and competitiveness while on the other hand, it also results in undesired consequences such as economic crises, social inequality, political conflicts, cultural degradation and ecological damage. This situation is clearly seen for today's global economies, which are largely shaped by the effects of scientific knowledge, advanced technology, effective innovation, effective R&D and entrepreneurship activities. It is not possible to achieve continuity in growth, development, competitiveness, efficiency and productivity without eliminating or minimizing undesirable economic, social, cultural, political and ecological consequences. At this point, it is important for a country to accurately understand the process of human capital formation, make accurate forward-looking predictions and develop appropriate strategies and policies to satisfy emerging needs and conditions. It should be noted that the impact of strategy and policy development on national productivity and efficiency can vary depending on various factors such as implementation, political stability, institutional capacity and external conditions. However, a well-designed and effectively

implemented strategy and policy framework can provide a solid foundation for directing efficiency and productivity growth and sustainable development.

Literature

Although human capital is directly associated with education, it has not received sufficient attention in the education literature and the majority of relevant literature has been concentrated in the field of economics. Given the rapidly and continuously changing dynamics of the global world, it does not seem prudent to explain and analyze human capital, which emerges as the fundamental driving force behind social progress, development and advancement and whose importance increases with each day and its effects and the outcomes it generates on the basis of a single discipline. On the other hand, although the concept of productivity, which is seen as the key to sustainable growth, development and global competitiveness for today's economies, is related to education, it has not taken its deserved place in the education literature. Most of the studies on productivity are concentrated in the fields of management, finance and economics. In the current study, the effect of human capital as an educational output on productivity was analyzed for 24 developing countries, including Turkey, which are in the upper middle income group, with an interdisciplinary research approach that brings together education, sociology and econometrics.

A summary of the relevant literature is given below:

In the study conducted by De la Fuente and Domenech (2001), the correlation between human capital and productivity was analyzed statistically. In the study covering the period of 1960-1990, a data set was constructed for 21 OECD countries. In the study that used the enrolment rate as a variable to represent human capital and the total factor productivity as a variable to represent productivity, a positive and significant correlation between human capital and productivity was identified.

In the study conducted by De la Fuente (2011), the correlation between human capital and productivity was analyzed statistically. In the study conducted on OECD countries and some regions of Spain, it was determined that human capital increases productivity. Furthermore, it was estimated that the social return on investment in human capital is higher than that of physical capital in many European Union countries and in several regions of Spain.

Abel et al. (2012) estimated the output per worker for metropolitan areas by using a density measure explaining the spatial distribution of the population in the USA. In this study, which tried to reveal the effect of human capital intensity on productivity, it was determined that doubling the human capital intensity increased productivity by 2% to 4%. The general conclusion reached by the study is that productivity increases depending on the increase in human capital intensity in metropolitan areas.

In the study conducted by Arshad and Malik (2015), the effects of education and health as human capital elements on labour productivity were analyzed. In the study covering the period of 2009-2012, 14 states of Malaysia were examined. In the study that utilized the fixed effects GLS method, it

was determined that education and health have a positive effect on labour productivity. In addition, it was determined that the health factor has a greater effect on labour productivity than the education factor.

Mannasoo et al. (2018) analyzed the effect of human capital on productivity. In the study covering the period of 2000-2013, data sets were established for 99 European regions from 31 countries. The study revealed that human capital has a positive effect on total factor productivity, especially in developed regions.

In the study carried out by Penekli (2019), the effect of human capital investment on productivity was investigated by using panel data analysis methods (Hausman Test). In the study covering the period of 1980-2017, analysis was made on all the countries of the world. The study revealed that there is a strong and significant positive correlation between human capital investment and productivity.

In the study conducted by Baharin et al. (2020), the effect of education and health as human capital elements on labour productivity was analyzed. In the study, which covers the period of 1981-2014, an analysis was made on Indonesia. In the study using ARDL method, it was found that education has a positive and significant effect on productivity in the short-term while the health factor do not have any.

In the study conducted by Begeç (2021), the effect of demographic structure and human capital on labour productivity was analyzed by using panel data analysis methods. In the study covering the period of 1991-2018, 115 countries, BRICS-T countries and Turkey were examined. As a result of the application, it was determined that human capital has a positive effect on labour productivity.

Gul et al. (2022) investigated the effect of human capital on labour productivity for Pakistan. In the study, in which the Generalized Moments Method was used, a positive correlation was found between the training of labour force and labour productivity. In addition, it was determined that a 1% increase in investments made in education creates a 0.10% increase in labour productivity.

Data Set and Method

The series analyzed in the application part of the study were obtained from the database of PWT10.0. Many studies have been conducted to reveal the human capital and productivity status of countries. In the current study, the Human Capital Index and Total Factor Productivity Index, which are within the scope of PWT10.0 prepared by GGDC (2019), are taken as the basis. There are two reasons for this. The first one is the focus of the study on "human capital as an output of education" in the human capital-education relationship. In the human capital indices developed by WEF, WB and UNDP, many other factors such as health and per capita income are included in addition to education. However, only the education factor is considered in the human capital index developed by the GGDC. The second one is that long-term series are included in the scope of PWT10.0. Long-term series are

expected to give more accurate results as they increase the number of observations on the variables to be analyzed.

In this direction, a panel data set was created by taking into account 24 developing countries in the upper middle income group for which data can be obtained for the period of 1980-2019. These countries are (1) Argentina, (2) Brazil, (3) Botswana, (4) China, (5) Colombia, (6) Costa Rica, (7) Dominican Republic, (8) Ecuador, (9) Guatemala, (10) Jamaica, (11) Mexico, (12) Malaysia, (13) Peru, (14) Paraguay, (15) Thailand, (16) Turkey, (17) South Africa, (18) Bulgaria, (19) Fiji, (20) Gabon, (21) Jordan, (22) Namibia, (23) Panama and (24) Romania. Logarithmic forms of the series were used in the analyses. Definitions of the variables analyzed in the study are given in Table 1.

Table 1. Definitions of the variables

Category	Variable	Abbreviation	Source
Productivity	Total Factor Productivity Index	tfpi	PWT10.0
Human Capital	Human Capital Index	hci	PWT10.0

In the current study aiming to analyze the effect of human capital as an output of education on productivity, the Human Capital Index (hci) was used as the representative variable to reveal the human capital status of the countries and the Total Factor Productivity Index (tfpi) was used as the representative variable to reveal their productivity status. In the application part of the study, the short-term relationship between human capital and productivity was analyzed by using the Granger Panel Causality Test and the long-term relationship was analyzed by using the Westerlund Panel Cointegration Test for 24 developing countries in the upper middle income group and for the period of 1980-2019. Time series graphs of productivity for the countries are shown in Figure 3, and time series graphs of human capital are shown in Figure 4.
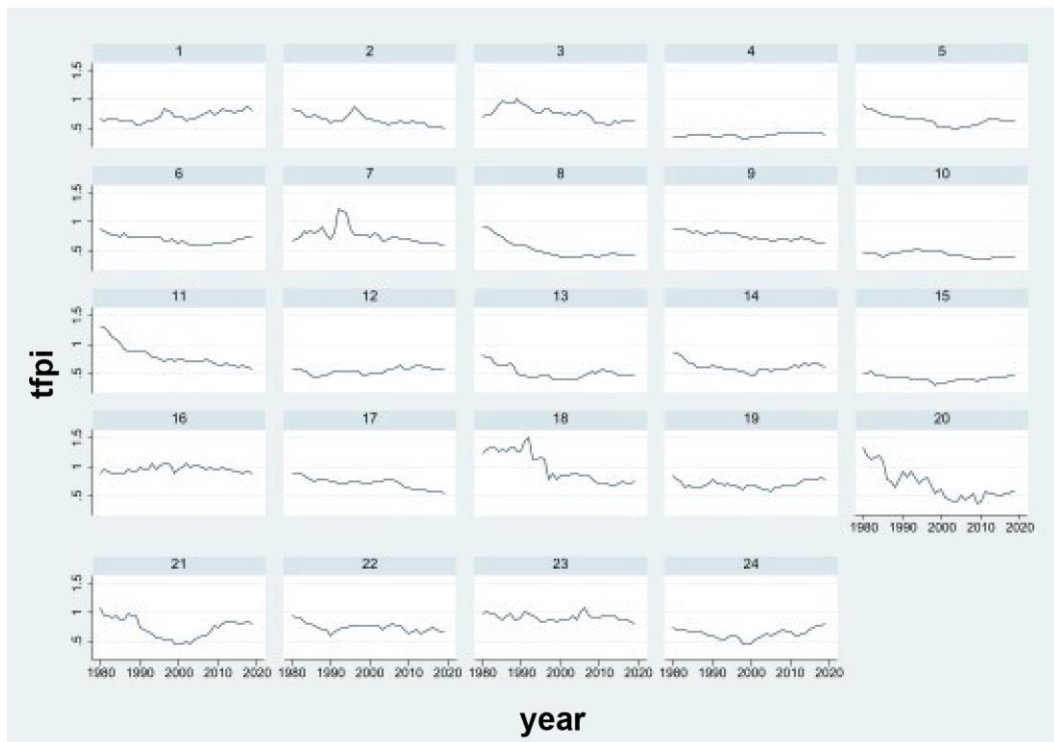
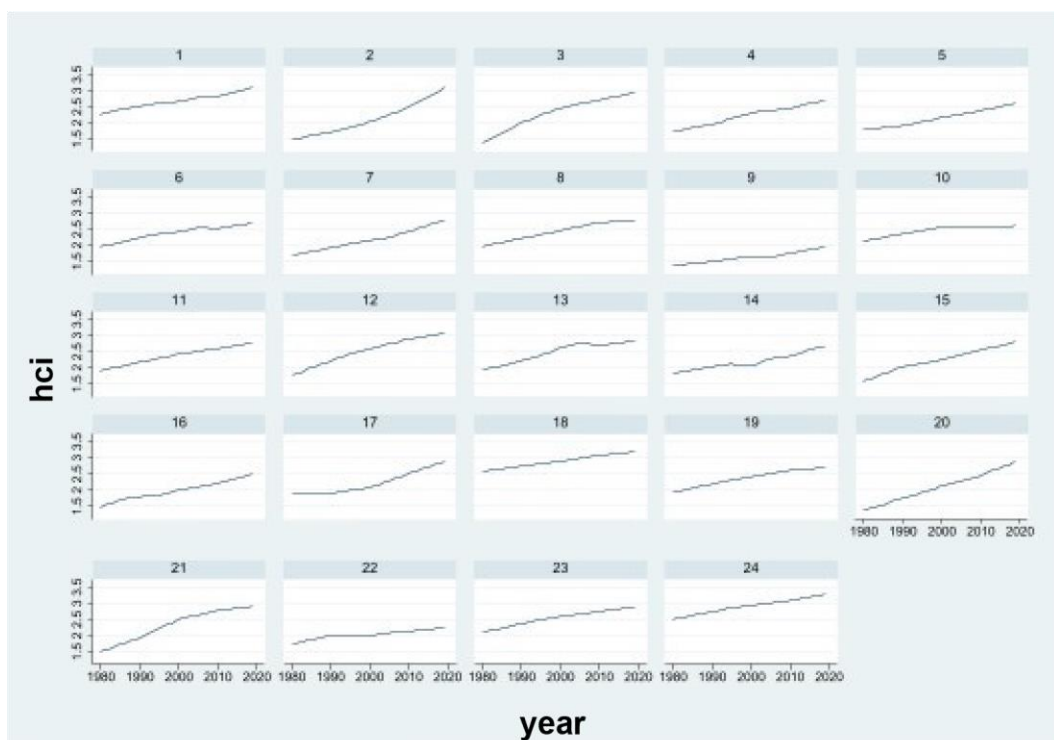**Figure 3.** Graphs of the total factor productivity index series (1980-2019).

Figure 4. Graphs of the human capital index series (1980-2019).

Data Analysis

In the current study, the following stages were followed within the context of panel data analysis, which is an econometric method:

1. First, descriptive statistics of each series were examined.

2. In the second stage, cross-sectional dependence test was performed for each series. For this purpose, Breusch and Pagan LM (1980) test was used.

3. In the second stage, cross-sectional dependence was determined for each series group, and in the third stage, unit root testing was carried out with the CADF Test developed by Pesaran (2007) (Balmumcu & Bozkurt, 2020; Bozkurt & Balmumcu, 2018; Bozkurt & Pekmezci, 2018; Göktaş et al., 2019).

4. In the fourth stage, the slope heterogeneity test was performed. For this, the test statistics that were developed by Pesaran and Yamagata (2008) were used.

5. In the fifth stage, the Granger Panel Causality Test developed by Dumitrescu and Hurlin (2012) was used to reveal whether there is a short-term relationship between the series (Pekmezci & Bozkurt, 2019; Pekmezci & Bozkurt, 2021).

6. Finally, in the sixth stage, the Panel Cointegration Test developed by Westerlund (2007) was used to reveal whether there is a long-term relationship between the series.

Application Results

In the application part of the study, first, the descriptive statistics of the series were examined. Then, the results of the tests applied for the analysis of the data were presented in tables. Descriptive statistics for each series used in the study are presented in Table 2.

Table 2. Descriptive statistics for series

Variable	Number of Observations	Mean	Standard Error	Minimum	Maximum
logtfpi	960	-0.188	0.127	-0.518	0.177
loghci	960	0.359	0.079	0.133	0.514

The results of the Breusch and Pagan LM (1980) Test Statistics used to test the cross-sectional dependence of the series in the second stage of the application are given in Table 3.

Table 3. Cross-sectional dependence test results

Variable	Breusch-Pagan LM Test Statistics	Probability Value
logtfpi	9725.79	0.0000
loghci	13027.91	0.0000

In Table 3, the probability level obtained from the test statistic is lower than the 1% significance level for each series and therefore the series group in question contains cross-sectional dependence.

Since cross-sectional dependence was determined in the series in the second stage of the application, unit root testing was carried out with the CADF Test developed by Pesaran (2007) in the third stage. The results are shown in Table 4.

Table 4. Panel unit root (CADF) test results

Variable		Z[t-bar]	Probability Value
logtfpi	At level	-1.554	0.869
	First difference	-2.218	0.010
loghci	At level	-1.171	0.999
	First difference	-2.096	0.045

As seen in Table 4, the series belonging to the logtfpi and loghci variables are not stationary at the level, but they have become stationary at the level when their new values at first difference are taken.

In the fourth stage of the application, the slope heterogeneity test was performed. For this, slope heterogeneity test which was developed by Pesaran and Yamagata (2008) was used. The results of the test are given in Table 5. The training of the model was found to be heterogeneous.

Table 5. Slope heterogeneity test results

	Value
$\widehat{\Delta}$	22.060*
$\widetilde{\Delta}_{adj}$	22.986*

Note: * denotes the %1 level of significance.

In the fifth stage of the application, the results of the Granger Panel Causality Test developed by Dumitrescu and Hurlin (2012) were examined to determine whether there is a causal relationship between the logtfpi and loghci variables for the short-term. These results are given in Table 6.

Table 6. Granger panel causality test results

	1 Lag Length			2 Lag Length			3 Lag Length		
	$W_{N,T}^{Hnc}$	$Z_{N,T}^{Hnc}$	Z_N^{Hnc}	$W_{N,T}^{Hnc}$	$Z_{N,T}^{Hnc}$	Z_N^{Hnc}	$W_{N,T}^{Hnc}$	$Z_{N,T}^{Hnc}$	Z_N^{Hnc}
logtfpi→ loghci	8.917	27.426*	24.583*	4.090	5.120*	4.230*	7.487	8.974*	7.304*
loghci→ logtfpi	19.684	64.723*	58.265*	11.974	24.432*	21.237*	5.571	5.143*	4.030*

Note: * denotes the %1 level of significance.

As seen in Table 6, there is a bilateral causality relationship in the short-term between the logtfpi variable representing productivity and the loghci variable representing human capital.

Finally, the results of the Panel Cointegration Test developed by Westerlund (2007) were examined to determine whether there is a cointegration relationship between two variables (logtfpi and loghci) for the long-term. The results are given in Table 7.

Table 7. Westerlund (2007) panel cointegration test statistics results

	Test	Value	Z-Value	Probability Value
	G_t	-2.953	-6.392	0.000
For logtfpi and loghci	G_a	-5.968	1.115	0.868
	P_t	-12.263	-4.974	0.000
	P_a	-5.988	-1.742	0.041

As seen in Table 7, there is a long-term cointegration relationship between the logtfpi variable representing productivity and the loghci variable representing human capital.

Results and Policy Implications

In the rapidly changing atmosphere of the global economy, productivity has become the key concept for long-term economic growth and development, regional and global competitiveness, raising social living standards and increasing the level of welfare for countries. It is not possible to talk about the progress and development of an economy without efficiency and productivity. As such, it has become crucial to identify the factors that can increase productivity levels for countries and to implement the right strategies, policies and practices that are appropriate for and responsive to the emerging conditions and needs. In the 21st century, when scientific knowledge, technology, innovation, R&D and entrepreneurship manifest themselves in every stage of the production process, human capital has come to the fore as an important and determining factor that increases productivity.

In its most general sense, human capital means the collective knowledge, skills, abilities, behaviours and health qualities of individuals in a country that contribute to their economic productivity and general well-being (Barro, 1990; Becker, 1994; Begeç, 2021; Berkman, 2008; Romer, 1990; Tunalı & Yılmaz, 2016; Yaylalı & Lebe, 2011). Education serves as a catalyst for acquiring and developing these valuable qualities. In the broadest sense, education is the process of imparting various knowledge, skills, abilities, attitudes and behaviours to individuals by taking into consideration the needs of the individual and society, as well as the conditions of the time. The knowledge, skills, abilities, attitudes and behaviours that are imparted to the individual in a planned, programmed and systematic way in line with the predetermined goals in the education process result in qualified, productive, dynamic and healthy human power. As an output of education, human capital is a critical factor for the economic growth, competitiveness and social welfare of a country. A good education system contributes to the general development of society by making people well-equipped, knowledgeable and analytical, critical, reflective and creative thinkers.

Human capital formed and shaped by education to a great extent significantly influences and enhances productivity by generating advanced technologies, fostering innovation, ensuring uninterrupted R&D activities, promoting entrepreneurship as a societal norm, constructing robust institutional structures with a focus on education and healthcare, strengthening infrastructure capabilities, cultivating a work culture and style suitable for the business ecosystem, enabling the effectiveness of production factors, developing management and leadership skills for firms/industries/economies and devising appropriate strategies and policies that address specific needs.

In the current study, the effect of human capital, one of the most important outputs of education, on country productivity was analyzed for 24 developing countries, including Turkey, which are in the upper middle income group. In the application part, a panel data set was created for the 24 countries included in the study with the series obtained from the database of PWT10.0 for the period of 1980-2019. The Human Capital Index (hci) was used as the representative variable to reveal the human capital status of the countries included and the Total Factor Productivity Index (tfpi) was used as the representative variable to reveal their productivity status. The Granger Panel Causality Test was used to determine whether there is a short-term relationship between the two variables and the Westerlund Panel Cointegration Test was used to determine whether there is a long-term relationship between them. As a result of the application, it was determined that there is a bilateral causality relationship between human capital and productivity in the short-term and a cointegration relationship in the long-term.

The result of the study largely supports the relevant applied literature (Abel et al., 2012; Arshad & Malik, 2015; Baharin et al., 2020; Begeç, 2021; De la Fuente & Domenech, 2001; De la Fuente, 2011; Gul et al., 2022; Männasoo et al., 2018; Penekli, 2019). This result is important in revealing the significant effect of human capital as an output of education on productivity. Productivity is the key concept of sustainable growth, development and global competitiveness for today's economies. In this connection, the following suggestions can be made for Turkey and other developing countries:

1. In order for human capital to develop as the driving force of social development and progress, enrolment rates should be increased at all levels of education, from early childhood education to higher education. Quality should be taken as the basis here and the supply-demand balance should be taken into consideration.

2. Expenditures made on quality education yield increasing returns in the long-term. Thus, resources allocated to education must be increased in order to enhance its quality and meet global standards and these resources should be utilized effectively and in line with their intended purposes.

3. A quality education system should be built for quality human capital. A quality education system provides an environment where everyone has equal opportunities and can fully develop their potential. Adequate funding, well-trained and qualified teachers, modern teaching

methods and resources, technology-integrated classrooms, up-to-date curriculum and infrastructure improvements are essential for a high-quality and robust education system.

4. In order to increase the quality of education, it is important for teachers to continue their professional development and to adopt up-to-date pedagogical approaches. When teachers' motivation is high, they strive to support their students more effectively and creatively. Administrators and policymakers of education should develop solution-oriented approaches to address the needs and issues of teachers (working conditions, workload, salary, benefits, etc.).

5. A culture of lifelong learning and continuous development should be encouraged to increase human capital accumulation to the desired levels. Formal education should be supported with informal education and continuous learning opportunities should be created in different fields such as vocational education and adult education. In this way, individuals can acquire new skills and knowledge, update their existing skills and adapt to the changing job market.

6. All members of society should have equal access to quality education. It is important that education is accessible to all. Inequalities in educational opportunities can hinder human capital formation and thus socioeconomic inequalities can be permanent. Necessary steps should be taken to ensure gender equality in education, to increase educational opportunities in rural areas and to establish support programs for disadvantaged groups. With an inclusive and equitable education system, the benefits of human capital accumulation can be maximized.

7. Increasing human capital as an output of education is not sufficient on its own. It is important that the human capital is trained in accordance with the conditions of the period and to meet the needs. In the face of rapid technological developments and changing global dynamics, the need for qualified workforce specialized in specific fields of industry, commerce and business world is increasing rapidly. Education process and policies should be structured to meet this need.

8. The ability of human capital, nurtured under limited resources and challenging economic conditions, to generate the desired positive externalities for a country depends on the ability to retain human capital within the country. Attractive conditions in developed countries attract human capital in developing countries. The loss of human capital (migration) should be prevented by providing the necessary attractive conditions and opportunities.

Conflict of Interest

There is no conflict of interest for the authors or third parties arising from the study.

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Ethical Statement

This study has been prepared in accordance with the rules of scientific research and publication ethics. It is a type of study that does not require ethics committee approval.

Credit Author Statement

The authors contributed equally to this research. The authors acted together and contributed equally in the conceptualization, design creation, method determination, data collection, data analysis, interpretation of the findings and writing processes of the research.

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