Current Studies in Educational Disciplines 2021

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Dr. S. Ahmet KIRAY

Dr. Elizabeta TOMEVSKA-ILIEVSKA

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Davut ALAN

Foreword / Discussions on Education from Multiple Scientific Disciplines

The proposed book with title Current Studies in Educational Disciplines 2021 is primarily intended to serve as a scientific reading that deals with multidisciplinary and currently determined topics in the field of education. The book is published continuously, is published every year and aims to cover topics with a broader educational setting / foundation.

The texts in the attached papers appear at the right time, we would use the term "real educational time" whose results and recommendations should be harmonized in the modern educational tendencies of several scientific disciplines that all have "one common denominator", which is to improve the quality of education. The papers, according to their content layout, are divided into 6 thematic chapters, seemingly diverse, but still each paper is an authentic, research paper of theoretical-empirical character that deals with very interesting, current and insufficiently studied issues.

The content of the book is based on clearly identifying the current challenges in the educational sector, which ensures its relevance by carefully defining the priority areas that need to be addressed in the coming period.

In this regard, the standards are especially elaborated as a basis for quality assurance and evaluation, the need to define them and build a consistent system such as Critical Security Approach to Climate Change with an Emphasis on Marginalized Global Inequalities.

One of the significant problems that are sensitively detected by the authors are and Evaluation of Pedagogical Approaches to Early Childhood Environmental Education: Perspectives and Relationship with Eco psychology Environmental Management as an Undergraduate Program of Study in Nigerian Universities: Challenges and Perspectives and reviews Towards ecological culture.

The identification of challenges and priorities and the determination of measures was done in several ways:

Logical to this sequence of elaborating and determining the problems in theoretical and empirical framework is also Evaluation of TIMSS 2019 and PISA 2018 Science Findings in Turkey Perspective, as well as the The Concept for Sustainable Development in Turkish Science Education. The Definition and Importance of Distance Education and the Use of Digital Stories in 21st Century Education are a kind of focus on the research interest, which is further reflected on the research part of the papers.

In the book some of the authors dwell on the conditions and trends of educational concepts, such as Interventions to address Mathematics Anxiety, An Alternative Method in Teaching Statistics: Creative Drama; Mathematical patterns.

At the center of the scientific interest are the topics in the field of assessment and evaluation system, the numerous recommendations that are presented as positive practices that lead to the improvement and strengthening of the quality of teaching, which state: Alternative Assessment Methods in Primary Education, as well as the Digital Assessment Tool: E-Portfolio; Argumentation integrated STEM activity.

The book offers theoretical and empirical elaboration of contemporary educational topics, many of them offered as didactic categories, but also with practical methodological guidelines for the implementation of modern approaches in educational work.

We are deeply grateful to all the initiators of this concept, to the authors for their significant contribution to this book, of which we are sure, will stimulate expert discussion, stimulate new research interest and will build new partnerships.

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Assoc. Prof. Dr. S.Ahmet KIRAY   Prof. Dr. Elizabeta Tomevska – Ilievska

Necmettin Erbakan University,   Ss. Cyril and Methodius University in
Konya, Republic of Turkey   Skopje, Republic of Macedonia

SECTION 1
ENVIRONMENTAL EDUCATION

Critical Security Approach to Climate Change with an Emphasis on Marginalized Global Inequalities

Faruk Hadžić
Independent Researcher

Introduction

While political and military issues remain critical in a broader sense, the concept of peace and security extends to economic and social threats, including poverty, communicable diseases, and environmental degradation. All of these are significant factors in undermining security. From an environmental perspective, environmental management integration into the more comprehensive development and humanitarian framework is no longer an option but an imperative of peace and security. In modern countries, the political, security, and other interests of citizens are modeled, transformed, gained in a content day by day, following the general changes of civilization. Today, security in environmental protection and preservation is one of the most critical security factors in the modern world. Until recently, climate change was a scientific phenomenon, the cause of which has not been scientifically confirmed. However, measurements and monitoring of trends in climatic parameters and their analysis undoubtedly show that the anthropogenic factor is the dominant cause of current climate change.

The emphasis is on the humanitarian, social, economic, and environmental dimensions of security, with the unquestionable importance of the principles of equality and the promotion of democracy. Various mechanisms are used, and the most demanding and most intensive are international interventions aimed at stopping conflicts. The complexity of their launch, the justification criteria, the principle of sovereignty, international stability - all these are questions that need to be answered before the international intervention. The cessation of conflict is not enough to establish long-term stability unless post-conflict construction and sustainable development follow. It is evident in Bosnia and Herzegovina, Kosovo, Rwanda, Iraq, and Afghanistan. The interaction of several factors almost always causes states of acute threats such as famine, conflict, and socio-political instability. The potential damage and extent of victimization are estimated. Present action and lack of action on climate change are likely to be the most difficult transnational environmental crimes" (White, 2011: 36). For criminologists dealing with global warming environmental and social, the damage resulting from it does not currently exist a washed body of international or domestic law which offers a legal framework for bringing this damage within the confines of criminology.

Furthermore, for many populations and communities that are socially marginalized and with insufficient natural resources, human security will continue to be progressively threatened as these climate changes take hold.

Some of these effects are immediately visible and occur very quickly, such as situations where typhoons destroy entire settlements and communities in seconds; Others take place gradually, so drought leads to crop destruction and leaves people without food and income, which further leads to changes in demographics and creates forced migrations and increased urbanization (UN, 2019). In addition to the most apparent effects reflected in health problems and the emergence of infectious diseases, climate change also directly affects the economic sector. Climate change is slowing economic growth by causing changes in ecosystems and terms of resource availability. It further affects economic growth through supply-demand relationships, then in terms of damage or increased investment in infrastructure, and finally, reduces the opportunities to create new jobs. Historical development shows that the drip economy does not exist, which means that not everyone benefits from economic growth. Social cohesion is essential for the economy's success because social and political unrest threatens its stability and prevents additional investment and growth. In the modern world, under the pressure of liberalization and the pursuit of greater profitability, the principles of social justice are sometimes neglected, although they are guaranteed by the constitutional order of almost all democratic countries in the world. International organizations, such as the United Nations, the World Bank, and the European Union institutions, point to the importance of human development and social justice and call for reflection on the future to promote social cohesion, as a new value of quality coexistence in the community (Pavisic, 2016). All of the above harms the economy and the economy of the country and directly harms human security.

When we talk about environmental security, the author focuses on the connection between environmental and human security changes regarding global inequalities. Discussions on environmental security are essential for the geopolitics of climate change because climate change can lead to degradation of ecosystems and human habitats, can lead to droughts, global warming, floods, storms, can endanger agriculture, horticulture, livestock, fisheries, and even lead to violent conflicts. According to Homer-Dixon, a lead author linking environmental degradation and violent conflict, disputes over environmental degradation are likely to lead to ethnic conflicts caused by migration, to social divisions caused by environmental scarcity, and to civil conflicts caused by environmental scarcity affecting life, economic activity, elite behavior, and state responses. Homer-Dixon's research points to the danger of major wars and other conflicts that can lead to environmental destruction and can play a crucial role in destabilized states, leading to the provision of shelter terrorists or criminal groups. It can lead to new geostrategic images in individual regions (Haldén, 2007). In some conflict regions, there is also a connection with terrorist activities.

It is also important to note that climate change and population growth, ozone holes,

and biodiversity loss fall under environmental safety (Dalby, 2007). Environmental security was introduced as a term by the UN. Title Critical Security Studies arose from discussions during and after conferences Strategies in Conflict: A Critical Approach to Security Studies Held at York University in Toronto in 1994. K. Krause and M. Williams used the title as the title of their book Critical Security Studies: Concepts and Cases that opened the door to developing new self-aware, critical security perspectives. According to Krause and Williams, the main task of Critical Security Studies was to be reconsidered reference object of security, thinking about security in a broader context than that implies only military security and a change in the very way of studying security alongside the rejection of the presumption of objectivity contained in traditional approaches (Mutimer, 2010). Although the critical attitude towards previous security studies resonated very quickly in academic and intellectual circles and has attracted scholars from a variety of theoretical perspective, an attempt to define it more broadly new direction of modern security study within Critical Studies as the umbrella name for all approaches is not he officially stayed. Instead, across Europe and the U.S., intellectual currents are opening up new debates to develop separate security studies within several perspectives and topics.

Critical Security Studies are established through scientists from Aberystwyth and their sympathizers as separate schools of thought. "Booth, Jones and their colleagues from the (so-called) Welsh school advocate the creation of a special critical security theory" (Mutimer, 2010) whose ideas should be based on the post-Marxist theory of international relations derived from Frankfurt schools. Critical security studies see states as unreliable in providing security, and they differ too much from each other, which is why state-based security theories like reference objects cannot be complete (Booth, 1991). Instead, it needs to focus on security put individuals, especially those to whom the current world order is the source of insecurity and prevents stability and prosperity (Buzan & Hansen, 2009).

Human security is a broad term consisting of two categories - "freedom from fear" and "freedom from want." The first term represents a broader definition and includes threats such as famine, infection, repression, and protection from a sudden disaster. The term is supported by the UNDP Development Report in 1944, by the Japanese Government, and the Commission on Human Security. The second term emphasizes threats to the individual (e.g., drug trafficking, mines, ethnic conflicts, dysfunction of the state, trade-in small arms). The "freedom from want" approach focuses on the immediate necessity and is therefore supported by the Canadian Government and the European Union (EU). The Social report, the United Nations Development Program (UNDP) in 1994 expanded the conceptualization of security and rehabilitated two fundamental freedoms of the 1945 United Nations Charter: "freedom from want" and "freedom from fear." It is possible to single out seven related human security elements: economic security, food security,

health security, environmental security, personal security, social security, and political security. As for international political relations, they are strongly influenced by climate change such as melting ice, heatstroke, floods, fires, and the like. Although the climate crisis leaves no country or community unaffected, its social impacts affect the world's most marginalized inequalities. Thus, minorities and indigenous peoples are already acutely feeling its consequences before many other communities.

Pluralism and social constructivism have opened up new perspectives in the study of security. The study of human security occupies an increasing space, and more attention is to the individual's security. According to the UN report, the two major components of human security are freedom from fear, meaning protection against physical violence, and freedom from want, addressing poverty (UN, 1992). The emergence of a new approach in critical security studies in the 1990s has expanded and deepened the notion of security. Security challenges are no longer considered military and non-military phenomena that existentially threaten states and other entities. The notion of human security evolved from a political and security shift in the post- Cold War period. New forms of conflict have emerged that have changed the notion of security and conventional notions of war.

The democracy, in its arrival, as a promise in the Universal Declaration of Human Rights, implies everyone, without restrictions. Everyone who is not the same and not related, but on the contrary, is singular in his human form. This promise is deeply connected with the belief in a different social and international order that will enable the world to be equally developed, be ruled by peace and the absence of poverty, and that everyone has the right to such an order to have the right to rights. It is up to us to ask ourselves seventy-two years later why this promise seems not only unbelievable but almost ironic today.

The analytical in-depth literature review highlights knowledge and research gaps and identifies relevant initiatives. The multidisciplinary approach explores future research's potential that could lead to more insights into the importance of the correspondence between political, economic, social, environmental, and security actors in global societies for the harmonization, systemic transformation, and improvement of the normative solutions.

Climate Change and Human Security

Pluralism and social constructivism have opened up new perspectives in the study of security. The study of human security occupies an increasing space and more attention to the individual's security. It is a clear departure from the conventional understanding of security. It is based on poststructuralist and constructivist theoretical concepts. This approach raised some fundamental questions about the state as a possible source of insecurity for citizens, the state's responsibility for security, and the international community's role in internal conflicts. It redefined the state's role as a reference object of

security, the nature of threats, and the scope of security, and epistemological shifts are also manifested in respect for ideas, values, and social norms, thus rejecting scientific object epistemological positivism. The Copenhagen School approach is defined in the book Security: A new framework for analysis (Buzan et al. 2018). There are two main elements to this school: the sectoral approach to the study of security, which Buzan set out in his book People, States and Fear (1991), and Waever's concept of securitization. Buzan's account of the five security sectors - political, environmental, economic, social, and military - is a well-known analytical framework, while the concept of securitization treats security as a product of the speech act. It is precisely sectoral analysis, which epistemologically does not belong to critical studies' postpositivism, which makes the Copenhagen School the main departure from critical security studies.

Inspired by the theses of the Frankfurt School, especially the works of Jürgen Habermas, proponents of a critical approach to security consider it necessary to establish such a theory which will encourage "emancipatory potential in interaction and communication" (Buzan & Hansen, 2009: 207 according to Wyn Jones, 2005: 223). Booth points out that emancipation is needed, not only in analyzes and political practices but also as a significant aspect of individual security. Emancipation at the level of individuals and groups will emerge from developing a secure political society and globally. Given that "security means the absence of threats" and emancipation it means "freeing people from the physical and human limitations that prevent them from exercising what they freely chose to do," what they create proper security is "emancipation, not power or order" (Booth, 1991: 319). Despite the proliferation of academic papers dedicated to rethinking security, much of the literature criticizing the Cold War approach to security remains devoted to conceptual issues, or as Ken Booth explained it, "thinking about thinking" instead of "performing thinking" (Bilgin, 1999: 31 according to Booth, 1997: 114). In contrast, political orientation has the task of increasing security through emancipation policy and community network development at all levels (Mutimer, 2010).

Human security, in its broadest sense, encompasses much more than the absence of violent conflict. It includes human rights, good governance, opportunities for quality education, health care, and the creation of conditions for each individual to have the opportunity and freedom of choice in realizing their potential. Every step in this direction is also a step towards poverty reduction, economic progress, and conflict prevention. The absence of any form of deprivation, the absence of Fear, and the freedom of future generations to inherit a healthy natural environment, are interrelated components of both human and national security (Brozovic et al., 2011).

Environmental security includes a complex of conditions, phenomena, and actions that ensure the ecological balance on Earth at the local, regional, and global levels; exclusion of any human activity that has a detrimental effect on the environment, a situation in

which there is no danger of causing damage to the natural environment and the health of the population. Environmental security has no boundaries and is a global problem, task, and obligation. An example of the extent to which climate change can have on the concept of human security can be seen in the following examples. At the same time, climate change is causing state fragility, poverty, social and economic disparities, and a combination of increasing the likelihood of conflict. Conflicts and forced migrations are more likely to occur in already sensitive and fragile states (McLeman, 2018). In this way, the already unstable situations will worsen even more, and with the further weakening of the state, the governments will not have the resources and opportunities to resolve them.

A. Giddens states that although climate change could lead to international cooperation between states, there are more substantial interests that encourage division. This division can best be explained by the example of the melting of Arctic ice. When the area was exclusively covered in ice and used for scientific research, cooperation between the states was high. However, as it became increasingly possible that new oil, gas, and mineral resources could be found in the area, cooperation ceased, and there was a division of interests and tensions among the countries that had been cooperating until then. Energy shortages are another consequence of climate change that could lead to military conflicts and jeopardize security and disrupt international cooperation. Reducing emissions could lead to a struggle among states for resources, and political leaders could use climate change to gain or retain power (Giddens, 2009). The agricultural sector is directly affected by weather conditions, and if these conditions are unfavorable, it will negatively affect crops, which is further reflected in reduced yields and further reduced export capacities. The increase in temperature has led to an increase in fungal diseases and pests that reduce crop production. Food security also builds on agricultural production and is linked: from shortening the production season, lack of irrigation water, loss of fertile soil due to desertification or floods, to supply chain problems (Advisory Committee on the Microbiological Safety of Food, 2018). In central Nigeria, this forgotten conflict, years of fighting between livestock and farmers, has killed more than 60,000 people in the last fifteen years - almost four times more than the terrorist organization Boko Haram. So climate change is a threat, and livestock farmers in Nigeria have fewer meadows to graze (Hein, 2018). We can conclude that the effects of climate change and other social, economic, and political components contribute to the spread of violent conflicts. This topic is not new, but it is becoming more and more serious. As early as 2008, psychologist H. Welzer warned in his book "Climate Wars" of the social order collapse due to climate change.

Simultaneously, the effects of climate change from drought to floods are not only felt local. Moreover, extreme weather events affect the growth of food prices globally, which increases the risk of conflict. Every time the price of food on the world market increases,

there are demonstrations, unrest, and then permanent social and political instability in thirty to forty countries at the same time. D. Smith cites North Africa and the Middle East: "In Syria, Egypt, and Yemen, climate change is recognized in the mosaic of causes of conflict." Thus, Syria is an ideal example of how climate change causes conflict: the world's most considerable drought in the mid-2000s.

Furthermore, we can problematize the frequency of migrations, i.e., mass escapes from changing environments. It is obvious: the economic and thus social consequences of climate change are dramatic. "On average, all regions will lose about ten percent of economic performance, tropical countries up to twenty percent - due to global warming, declining productivity in the agricultural sector, but also due to declining labor productivity - significant figures" (Kalkul, 2016). Moreover, global warming is likely to be more than 2 ° C by 2060 compared to pre-industrial levels and could rise to 5 ° C by the end of the century (EU Council, 2020). The most significant causes of large population migrations are, for the most part, security, social and economic-propaganda nature. These causes are mostly induced through crises, wars, and military interventions of leading countries Of the West, guided exclusively by neoliberal capitalism's values and logic, caused in many world regions has moved millions of poor, displaced, disenfranchised, and vulnerable to leave their home countries searching for a new life. However, the principle of non-refoulment is a fundamental principle defined by the Convention Relating to Refugees in 1951. Protects refugees outside the country of origin from being forcibly returned to an area is the likelihood of being persecuted, tortured, or killed. Article 33 of the Convention reads: "No Contracting State may expel or return a refugee, in any way, to an area where his or her life or liberty would be endangered by care- not racial, religious, or national affiliation or because of belonging to a particular social group or because of a political one opinions."

If entire regions become impoverished in a globalized world, this can increase migration and cause congestion within a country's borders or increase tensions internationally. We can recall the refugee debate in Germany, where in a relatively short period, a year, two days, a million people came to the country, which brought great fragility and instability to politics. Thus, in 2018, in Saxony (which became one of the right-wing strongholds of parties fiercely opposed to migration in Germany), in the city of Chemnitz, demonstrated first hundreds and then thousands of anti-immigrant protesters - after a series of violent clashes that followed because two immigrants killed a German. The arrest warrant of one of the suspects found its way to ultra-rightist groups (the Pro Chemnitz group, the AFD party, and the anti-Islamic Pegida movement), which published it on the internet and thus mobilized supporters. All this was followed for days by the mainstream media, increasing the importance of events and giving populists an even more "open" space to spread Fear and Islamophobia and polarize society for and against refugees. A friend of

the murdered German stated that right-wing protests were fueled by inaccurate media reports, which resulted in random attacks on foreign nationals or people who "look like foreigners" and new violent protests in which members of the far-right and left clashed (Hrupić, 2018: 17). The suffering and social chaos intensified previous tensions, which later spiraled out of control and escalated into the war we see today. The loud public's discourse within mass psychology is often a reflection of the discourse of the power structures, and this, of course, is aided by the detection, external and internal, of enemies (Hadžić, 2020). That is why it is challenging to predict the reaction of society to mass migrations of people.

Moreover, as with terrorism, which also affects Lebanon, Syria, and Nigeria, and the like, the consequences of climate change are a boomerang that first and foremost affects the most vulnerable groups. Like terrorism, the West exported air pollution, a common good. While industrial civilization flourished through the colonialist plunder of natural resources, coal and oil's burning triggered the atmosphere's unstoppable accelerated warming. The war in Syria and climate change are also linked. A United Nations study (2019) vividly illustrates this connection: the extreme droughts of the 2000s, the 40 percent reduction in water in the Euphrates River, poor water management in Syria, and numerous failed harvests led to a mass exodus from the countryside. Consequence: mass unemployment, social inequality, poverty, and crime. When the Arab Spring arrived in Syria in 2011, the country was in an explosive state - the brutal oppression of the opposition ultimately led to an explosion of violence. As early as 2012, a joint US secret service document predicted that "there would be water shortages or floods in many countries that are important to the United States." It could increase the risk to the stability of those countries and lead to regional tensions (Hein, 2018).

A growing body of literature analyzes global warming and climate change from a criminological perspective (Kramer and Michalowski 2012; Michalows and Kramer 2013). Higgins defines ecocide as: "The destruction, damage or loss the ecosystem (s) of a particular territory, whether human agency or for other reasons, such so much so that the peaceful enjoyment of the inhabitants of that territory was seriously reduced" (Higgins, 2010: 63). If adopted, it would be legal definition according to which global warming and climate change would become, not just an environmental problem, but also an international crime.

Besides, there is lacking international security activities and initiatives. There is no focused, operational response in the Sahel or the Middle East to help communities adapt to climate change and avoid violent conflict risks (Smith, 2019). Thus, in addition to a country's exposure to the effects of climate change, the ability of governments to adapt and combat the harmful effects of climate change is also essential. Moreover, closing borders without addressing systemic causes will certainly not solve terrorism, which is another link between terrorism and climate change.

The Marginalized Inequalities and Climate Change

Although the climate crisis leaves no country or community unaffected, its social impacts deepen the world's most marginalized inequalities. Thus, minorities and indigenous peoples are already acutely feeling its consequences before many other communities. We have many examples. South Asia's Dalits, frequently concentrated in areas lacking water and sanitation access, are often left vulnerable during monsoons. Exclusion of these communities could emerge from emergency assistance due to discrimination. The 2005 Hurricane Katrina, 2012 Hurricane Sandy, and 2017 Hurricane Maria in Puerto Rico in 2017 disproportionately impacted African-Americans and other minorities. Indigenous populations have been identified as a highly vulnerable group within a global discourse on climate change because of habitation in regions undergoing rapid change and the disproportionate burden of many groups' morbidity and mortality. Yet our understanding of the human dimensions of climate change for indigenous populations at a global level is limited. Ford et al., for instance, noted how indigenous-focused content has been largely overlooked in assessment reports of the Intergovernmental Panel on Climate Change (IPCC), other major assessments, and in policy discussions surrounding the United Nations Framework Convention on Climate Change (UNFCCC) (Ford, 2012). Moreover, the Sámi and other indigenous communities are rapidly adapting as melting ice and other changes threaten traditional livelihoods in the Arctic region, where temperatures rise twice as fast as the rest of the planet.

The neoliberal capitalist system of the modern age, based on the ideology that markets alone achieve effective results, again became the prevailing doctrine in the late 20th century, is often blamed for declining social rights and rising inequality. The theses mentioned in the literature have not yet been sufficiently researched, which is an incentive for further research. However, there is no doubt that there is a constant tendency to reduce state powers and services provided by the state in neoliberal capitalism, which makes it difficult for the most vulnerable to access several services (health, education). According to the so-called the 1989 Washington Consensus, adopted in support of a globalization process that favors market fundamentalism and advocates liberalization and deregulation, has, in many ways, deepened the economic problems of developing countries and increased inequality (Stiglitz, 2004). The critical issue due to climate change is increasing hunger. Moreover, conflicts and climate change are fueling famine. However, the democracy, in its arrival, as a promise in the Universal Declaration of Human Rights, implies everyone, without restrictions. Everyone who is not the same and not related, but on the contrary, is singular in his human form. This promise is deeply connected with the belief in a different social and international order that will enable the world to be equally developed, be ruled by peace and the absence of poverty, and that everyone has the right to such an order to have the right to rights. The new World

Hunger Index shows the following: No man needs to be hungry. It also shows that earlier achievements in this field are being undermined by armed conflict and climate change.

The issues are a shortage of water, and food became overpriced. Since 2017, the famine in the Central African Republic has been marked in red again: the general situation for food is frightening in this country torn apart by armed conflict. Malnutrition in the entire population is more the rule than the exception. Every eighth child dies before their fifth birthday. Surviving children are too short for their age, suffering from exhaustion and stunted growth. Based on these four factors, famine in the Central African Republic is classified as the worst. In four other countries, the situation is dire - in Chad, Madagascar, Yemen, and Zambia. 43 of the 117 countries included in the index are in the "serious" category. In total, according to the report, 822 million people worldwide suffer from hunger. (Grebmer et al., 2016) In 2013., that number was below 800 million. The UN Rapport on Extreme Poverty and Human Rights, in the report "Climate Change and Poverty" in 2019, put forward the thesis that the world is threatened by the era of so-called climate apartheid in which inequalities in societies will deepen as a result of climate change, and the human rights of many will be jeopardized (Centar za mirovne studije, 2019).

Two factors play a role in increasing the number of hungry people in the past three years: one is the effects of climate change and the increase in armed conflicts worldwide. "Wars and armed conflicts need political solutions to adapt to climate change. "The World Hunger Index 2019 shows that human action will make it increasingly difficult to feed the population sufficiently and sustainably." (Peterson, 2019). The World Hunger Index has been published since 2006. Since the early 1990s, weather disasters have doubled worldwide, leading to crop losses due to droughts, floods, soil erosion, and storms; the poorest countries, where hunger is most significant and no social security, have been hit hardest by climate change. "A higher concentration of $CO2$ in the atmosphere leads to a reduction in micronutrients in crops, too little protein, zinc or iron. Basic foodstuffs such as wheat, rice, corn, and soybeans were affected by the more inferior nutritional value. It affects the poorest the most because they use those grains as a staple food (Peterson, 2019).

The agricultural sector is directly affected by weather conditions, and if these conditions are unfavorable, it will negatively affect crops, which is further reflected in reduced yields and further reduced export capacities. The increase in temperature has led to an increase in fungal diseases and pests that reduce crop production. Food security also builds on agricultural production and is linked: from shortening the production season, lack of irrigation water, loss of fertile soil due to desertification or floods, to supply communities and the economy, with a thorough understanding of which sectors and population chain problems (Advisory Committee on the Microbiological Safety of Food, 2018).

The neoliberal economy, characterized by deregulation of the market and reduced costs in the public sector, has created a global monopolistic market. Instead of strengthening national social programs, most countries worldwide are increasingly taxing the poor, reducing public sector spending, and privatizing education and health care, often following financial institutions such as the International Monetary Fund. A recent Oxfam study found, for example, that super-rich Latin American individuals have influenced politics and the media in their countries in various ways (Sisgoreo, 2020).

At the same time, we have forgotten groups, i.e., more impoverished and marginalized social groups, to which climate change has taken away the last resources to be able to emigrate somewhere at all. Within that framework, mass floods in the Western Balkans in 2014 can serve as another example. Official figures say more than 1.6 million people have been affected in Serbia and Bosnia, just a week after the floods began. The 2014 floods resulted in the loss of 79 lives, the evacuation and displacement of close to a million people, with a significant number of lower social class, Roma minorities, farmers and the elderly, tens of thousands of houses, livestock, agricultural land, schools, hospitals, and businesses, with significant damage in Croatia, Bosnia, and Herzegovina and Serbia. At the same time, significant risk reduction requires an understanding of groups' vulnerabilities are at risk. For example, the impoverished population, Roma minorities, farmers, Asian-African migrants-consequences of the Europan migrant crisis, and the elderly require special insurance schemes. These differences must be understood and treated appropriately in all future development plans for the Western Balkans.

Real estate is one of the consequences of climate change before we talk about "climate refugees" and others. P. Alston, the UN special rapporteur on extreme poverty and human rights, calls it the climate apartheid. "We risk getting into a climate of apartheid where the rich can afford to escape from overheating, hunger, and conflict while the rest of the world's population has to suffer from climate change" (Aston, 2019).

While it is rightly held that poverty is one of the leading causes of human rights threats and that development can break the vicious circle of poverty, in many African, Latin American, and Asian countries, development is seen as a source of violence against human rights. In many development policies of the countries there, development is equated with the following negative phenomena: depletion of non-renewable natural resources; appropriation of the goods of poor peoples; excessive use of chemicals in agriculture leading to soil and water pollution and in some cases disruption of food chains; accelerated industrialization of imported technologies and waste; development of tourism based on the construction of large hotel complexes that deprive the local population of space and resources, mostly water; prostitution, including children; population displacement, especially of indigenous tribes; mega-development projects that bring countries into debt; increasing injustice and corruption. The author argues

that communities and societies that are particularly sensitive and receptive to these are already weakened by conflict and bad governments. Climate change throws such societies into political instability and food shortages and causes large migration waves. Such movements further destabilize, which can lead to violent conflicts. This unbreakable chain exists in other regions, such as Mali or Sudan. Even in seemingly stable countries, such as Jordan, the effects of prolonged drought in the van, a nation with a massive influx of refugees from Syria, could upset the balance and lead to instability (Vivekananda, 2017).

Conclusion

Climate change threatens the future of human rights, threatening to undo the development, health, and the fight against poverty. If climate change is not mitigated by the end of the 21st century, it will lead to unmanageable economic, social, and political conditions, and the opportunities for stable international and domestic policies will be significantly damaged. Such drastic changes will affect security dynamics that will be difficult to sustain with the current international system. The critical security studies, and the role of scientists in the field, should be not to establish "objective truth" but to enable a broader understanding of security based on respect for specific theoretical and political starting points in its conceptualization. Critical security theory should be both a theoretical commitment and a political orientation, as a set of ideas that critically and continuously explore communities and emancipation. A positive shift towards a gradual solution to the problem is the maturing of the collective consciousness of the necessity of shaping a new, more just, and humane society and transforming that consciousness into a social upheaval everyday reality. Addressing socio-economic and other disparities within minorities, indigenous, non-indigenous populations, global impoverished, and community empowerment are crucial to addressing existing challenges and increasing climate change resilience. To tackle persistent poverty, growing inequalities, frequent natural disasters, depletion of natural resources, destruction of the environment, and climate change requires joint action at all levels, from governments to individuals.

Issues of environmental security and protection are issues of overall security. Its social impacts on minorities and marginalized individuals and groups deepen the inequalities. Poverty is and remains the fundamental problem of world hunger. Regarding the geopolitical consequences of climate change, such changes already impact armed conflicts and mass migration. Such migrations will require elaborate state tactics and a peaceful solution to the flow of problems. However, if such a peaceful solution is not reached, the scale of the conflicts and catastrophes that will ensue is questionable. As global warming, excessive rainfall, and severe droughts affect agriculture, food supplies will fall, increase food prices, and increase poverty. Such a situation could potentially lead to conflicts and wars, and terrorism itself.

At the same time, in the future, significant struggles could be waged over drinking water supplies. Those parts of the world that are already struggling with drinking water quantities are likely to experience its complete loss in a few decades. There can also be armed conflicts in countries that seek to retain resources for which there is greater demand than supply.

Finding timely answers would help communities and groups, it would also save funds, and if terrorism on the ground were at least partially suppressed, it would be much cheaper than purely military responses. The constant readiness is critical to solve the issues of climate change globally. Risk assessments involving spatial and socio-economic analyses to understand hazard exposure and vulnerability should be mapped, analyzed, exploited, and shared by all.

It is necessary to build a global care system that would reduce the gap between rich and poor, within a more humane economy based on equality, and more progressive taxation. The existence of a quality state apparatus, an efficient rule of law, and a welfare state can alleviate inequality, but it will always exist to a greater or lesser extent. The future society is a society in which man and his dignity come first because behind all the great ideas, innovations, and achievements is a man and his motivation.

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About Author

Faruk Hadžić is an independent researcher and an author with a multidisciplinary academic background and research interests from Bosnia and Herzegovina. His research is multidisciplinary in Social & Political Psychology, Political Science & International Relations, Sociology & Socioeconomics, Critical Security Studies, and Criminal Justice. He primarily publishes in an international academic journals. Email: faruk.hadzic01@gmail.com,   ORCID   iD,   https://orcid.org/0000-0003-1158-7858,   ResearchGate,   https://www.researchgate.net/profile/Faruk-Hadzic-3

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Evaluation of Pedagogical Approaches in Early Childhood Environmental Education: Perspectives and Relationship with Ecosychology

Elif Ozturk

Giresun University

Introduction

There are multiple definitions in the literature on environmental education. It is known that the basis of these definitions was created by William B. Stapp in 1964. According to William B. Stapp, environmental education is an educational process aimed at raising useful individuals who have knowledge about the environment and environmental problems, can produce solutions for environmental problems and try to solve these problems (Kütük, 2019). In addition, environmental education is based on actions aimed at increasing the environmental awareness of the society and creating a framework for the protection of the environment (Laing, 2004). Environmental education not only conveys environmental information to individuals, but also contributes to the development of positive attitudes and behaviors towards the environment (Erten, 2004). Environmental education can also be considered as a means of science education because it is based on learning based on experiences, develops problem-solving skills, enables children to gain experiences, and is an education based on active participation (Gardner, 2009; Sugg, 2008).

Although environmental problems in recent years pose more problems for young children, environmental education practices in early childhood started later in educational institutions such as primary and secondary schools (Elliot & Davis, 2009). Considering the early childhood learning characteristics, it has a critical role in helping children acquire positive attitudes towards the environment in relation to other periods of life (Tilbury, 1994). If children develop negative attitudes towards the environment in the early stages, these attitudes will most likely become permanent. In addition, it is pointed out that learning at early ages is largely neglected and early period is critical age in the context of environmental education (Tilbury, 1994).

Talking about the existence of a healthy environment from the early years is possible with an education integrated with ecopsychology. It has been proven that the environment even affects the psychology of living things Ayaz (2014). The concept of ecopsychology explains this situation. In today's world, one of the most powerful remedies for children's unhappiness and restlessness is nature. Ecopsychology especially helps children to have a sense of moral responsibility towards nature and other people by developing the ego about the environment. In terms of raising awareness and sensitivity about the environment in early childhood, researchers have drawn the attention of this period and declared that it

is the most important period of life. Environmental education given especially between the ages of 3-6; It is important for children to acquire environmental awareness and sensitivity and to develop positive emotional bonds towards the environment (Biriukova, 2005). In this direction, they stated that environmental education has a significant effect on the change of preschool children's perspectives on the environment, and in this context, children should be introduced to environmental education in early years (Shin, 2008).Sarikaya (2006) in his study; problem-based learning known as student-centered teaching methods, learning cycle, multiple intelligence theory, 4MAT, brain-basedlearning, constructivist learning, project-based learning, inquiry-basedlearning), emphasized the use of approaches and methods such as active learning in science education, environmental education and other fields will ensure the realization of permanent learning in students.

Environmental Education and Practice Partnership (EETAP, 2002) stated that one of the benefits of environmental education outside the classroom is that it enables active learning and reconstructs the previous knowledge of the student. In this study, it was determined that the trainings were given in the natural environment based on the nature of the subjects, mostly based on observation and questioning, and environmental awareness developed (Okur Berberoglu, 2013). According to Ozaner (2007), an ecology-based environmental education is one of the best methods that enable individuals to learn about science and the environment. She has come to the conclusion that well-planned field studies in out-of-school spaces will not only facilitate students' understanding of the world around them, but also enable them to acquire positive attitudes and values towards nature and the environment. In their study, Cutter-Mackenzie and Edwards (2013) stated that integrating environmental education, which is considered in the context of pedagogical play types and structured games, into learning processes has a significant contribution to children's early learning. Torquati et al. (2013) similarly emphasized in their study that the curriculum content used in environment and nature education in early childhood education should be handled in an integrated context with nature and activities for children should be handled in a way that includes nature-based learning.

In a study in which Okur Berberoğlu (2015) examined the effect of ecopedagogy-based out-of-class environmental education program on environmental awareness of participants, she concluded that ecopedagogy-based out-of-class environmental education program increased the environmental awareness of participants. Akbayrak and Kuru Turaşlı (2017) examined the effect of game-based learning activities on the environmental awareness of preschool children and concluded that the activities supported children's environmental awareness, enriched children's environmental awareness and broadened their perspectives. The findings of the study titled "My Best Teacher Nature: Teacher Activities Prepared within the Scope of the Preschool Nature-Based Education

Applications Project" by Temiz and Karaarslan Semiz (2019) showed that teachers who did not practice nature activities a lot before participating in this project were able to use nature and natural materials at the end of the study. They have prepared various activities. With this project, it is aimed to establish nature-based education practices in Turkey from an early age, to encourage teachers to use nature in their immediate environment in education programs, and to make nature-based education widespread in schools.

When we look at the studies in the field of environmental education, it is seen that researchers constantly offer new approaches in order to maximize the efficiency obtained from this education. In line with the applied approaches, the determined objectives and functioning of environmental education in early childhood may differ (Ministry of Environment, 1998; Özdemir, 2007; Yılmaz, 2016). These approaches will be explained and examined separately in line with the relevant literature below.

Environmental education, which is initiated from early childhood, is important in terms of improving human and environmental interaction in a positive way from early childhood and raising sensitive and respectful individuals towards the environment. Creating environments that will provide life based on the active participation of children in the early years is one of the important dynamics of environmental education. In this context, in early childhood, children should be aware of their responsibilities towards environmental problems and especially recognize their environment in order to strengthen their relations with the environment. In the context of these principles, the aim of the chapter is to address and introduce current pedagogical approaches in environmental education, based on child-centered natural environment and child interaction, providing active learning, inquiry-based, in the light of the principles of ecopsychology in today's world, which has moved away from the context of ecological relations. Considering all these issues, this chapter aims to introduce the effectiveness of ecopsychology and current pedagogical methods that center children in environmental education, unlike traditional methods, and to consider alternative approaches in an inclusive and holistic way, to adopt approaches that will add differences to the processes of children's understanding of nature and the environment, and to create environmental education in this direction.

This chapter was carried out within the framework of critical theory. As this work is informed by critical theory, it uses the method of critical inquiry, which is the operationalization of critical theory in the social sciences. At this point, there is a definite need to justify what makes this present study "critical". From the perspective of critical theory, just exploring and recording social behavior is not enough. For social research to be useful, the next step in explaining this behavior in terms of socio-economic and cultural context is essential, that is, social research must go beyond 'fact-gathering'. In this chapter approaches that have entered the literature around the world in early

childhood environmental education are defined, explained and critically examined.

Pedagogical Approaches in Early Childhood Environmental Education

1. Nature-Based Approach: Nature Pedagogy

Simply put, nature-based early childhood education for young children (0-8 years) is where learning takes place in the context of nature. Many program models that are considered nature-based early childhood education (NbECE) such as nature-based kindergartens (also called nature-based kindergartens), forest kindergartens (also called forest kindergartens), nature-based kindergartens, nature-based first grade, nature-based kindergartens, and the like has. In all these programs, nature is at the heart of the curriculum, there is ample time outdoors daily during a school year, and teachers engage in high-quality environmental education practices alongside high-quality early childhood practices. In other words, nature and the outdoors permeate almost every aspect of a nature-based education program. Therefore, although the model or program structure may vary, there is a common approach to teaching children: nature pedagogy.

Nature-based kindergartens, sometimes simply referred to as nature kindergartens, are licensed early childhood programs for 3–5-year-olds in which at least 30% of the classroom day is excluded, infusing nature and pedagogy in all aspects of the programme. It emphasizes inquiry-based learning through play and hands-on exploration. This means that the curriculum is emerging (that is, based on children's interests) but typically based on seasonal events of the natural world, given their frequent experiences of time spent outdoors. In addition, nature is integrated with interior spaces and playgrounds generally have the appearance of a natural area rather than structured playground equipment. Nature-based kindergartens include time spent beyond the designated playground, nature indoors, and nature as the main theme of the curriculum (Bailie, 2010; Green Hearts, 2014; Larimore, 2011b, 2011; Moore, 2014). Another way to describe it is the integration of nature with learning "inside", "outdoor" and "beyond" (Warden, 2015). Nature-based kindergartens differ from forest kindergartens, which spend longer outdoors (70-100%) and have limited indoor use (Larimore, 2016; Sobel, 2014).

It has been observed that the concept of school gardening was first expressed by John Locke, and thus gardens and horticultural practices began to be used in educational settings (Johnson, 2012). Expressing that early childhood is more important than other periods of life, Jean Jacques Rousseau emphasized the necessity of applying education through natural environment and nature-based experiences in this period (Gravez et al., 1996). Influenced by Rousseau's views, Pestalozzi aimed to establish a strong relationship between children and nature through nature-based activities such as nature walks and nature observations in his school. Another educator, Friedrich Froebel, who was influenced by Rousseau's views and practices, can be seen in his own synthesis as

well as Rousseau's views in his educational works on children. Froebel, who spent his early life in touch with nature and was the founder of the first kindergarten in Germany, provided children with learning opportunities both inside and outside the classroom. It has created planting-planting areas for children in the garden of their schools, thus providing educational practices that can improve and support children's harmony with nature. (Garrick, 2009; Royce, 2012; Tovey, 2007).

Froebel's views and practices have provided the basis for the development of early childhood education in many countries. John Dewey was also influenced by these practices of Froebel and attached great importance to planting practices where children like Froebel could observe nature. In his discourses on education, Dewey often emphasized the importance of learning environments outside the classroom and argued that areas such as gardens and forests should be used effectively in the education of children in this direction (Herrington, 2001; Rivkin, 1998). Emphasizing the importance of the relationship between child development and clean air, McMillan attached great importance to the garden design of the school he opened. By creating the school garden from different surfaces, special planting areas were created for children, and also benefited from the hills and sandboxes (Bilton, 2010; Garrick, 2009; Tovey, 2007). Maria Montessori is another educator who argues that natural environments and gardening practices should be used as a learning environment for children. Rudolf Steiner, on the other hand, embraced the interaction of nature and children and the harmony of children with nature more than Montessori. The Waldorf approach, developed by Steiner, attaches great importance to nature-based play and learning activities. It has been concluded that through these games and activities, children's change and development in nature is pioneered. In particular, planting and harvesting practices are stated as one of the most important channels to gain a desired attitude and responsibility towards the environment and nature (De Souza, 2012; Edward, 2002; Schmitt-Stegmann; 1997).

2. Forest Schools

Forest schools are a system built on basic dynamics all over the world. By adopting the play pedagogy as a principle, the forest school has brought a unique dimension to contemporary outdoor education by focusing on young children. The concept of play, which puts children at the center and considers the active participation of the child, is seen as a new and potential principle and it not only brings a new breath to educators, but also opposes the current understanding of education (Leather, 2016).

Forest schools have been an environment that not only supports children's development with a multidimensional and holistic perspective, but also offers them the opportunity to become self-confident and aware of their competencies (Tantekin & Yalçın, 2017). The determining factor behind forest schools is that children learn more outside the

classroom than in unconventional environments. The target audience of these schools is especially aimed at kindergartens and primary school children (MacEachren, 2013).

The forest school is held in a forested area or a natural wooded area in order to develop the relationship between children and the natural environment. The reason for choosing a forested area in particular is that it meets the needs of the program and the student, is the most suitable environment for the philosophy of the approach, and contains elements that can stimulate children's feelings of discovery. Forest schools aim to establish long-term environmentally viable behaviors and child-nature relationship through children's experiences. It is seen that this nature-based education approach is adopted and examples are seen in different countries around the world.

a) Denmark, Sweden, Norway: Nature-Based Kindergartens

Its basic philosophy is based on the idea that "if you make your child love nature, the awareness of protecting nature and a positive attitude towards nature will develop spontaneously." Because the understanding that an individual will only tend to protect something he loves and values is adopted. This understanding is also reflected in the name of the applications made in Sweden (Sevimli Çelik and Yalçın, 2020). In line with this philosophy, education is carried out in areas such as forest, woodland, lake and seaside, which have a dynamic structure that changes depending on the climate and season (Linde, 2010; Robertson, 2008). The pedagogical arguments are as follows; knowledge and skills are gained through activities performed in nature in the child's close environment and requiring direct contact with nature. This information, based on the experience of children about their local, natural and cultural environment, is also very important for the protection of cultural heritage (Lysklett, 2017).

b) Germany: Forest Kindergartens (WaldKindergartens)

Waldkindergart institutions, which was founded for the first time in Germany in 1991 and which we can translate into Turkish as a forest kindergarten, was established in Flensburg, Germany under the leadership of two educators named Petra Jäger and Kerstin Jebsen (Lysklett, 2017; Quetteville, 2008; www.waldkindergarten.de). It is seen that these institutions in Germany serve 0-3 age groups and 3-6 age groups. In addition, they have two different institutional structures as integrated and pure. Çizioğlu (2020), unlike other sources, mentioned that these institutions have three main purposes in the platform where he shared his observations. He summarized these three main objectives as follows; to be a citizen of the world, to have awareness of nature and to be peaceful. He argued that this basic purpose was reflected in every question asked, every project carried out and every association in German nature schools. In summary, the foundations of forest kindergarten (Waldkindergarten) institutions in Germany date back to Froebel, and current practices are inspired by Scandinavian countries.

c) England: Forest School Approach

The Forest Schools "Forest School", which has a similar founding story to the Waldkindergarten institutions in Germany, is the British establishment. The establishment of these institutions is based on the visit of a group of teachers and students from Bridge Water College, early childhood education department to nature kindergartens in Denmark in 1993. Many studies have been conducted on children aged 3-11 years studying at Forest Schools in England, which provide education in line with the principles of this approach, examining the possible benefits of this practice for children. The common results of these studies can be summarized as follows: Forest Schools support children's self-respect and confidence, cooperation and awareness of other individuals, language and communication, recognizing and understanding themselves and their environment, attention and concentration, risk taking and problem-solving skills (Borradaile, 2006; Hughes, 2007; Massey, 2003; O-Brien & Murrey, 2007).

d) Australia: Bush Kinder Approach

Bush Kindergartens or Bush Kinder Approach has emerged in Australia, with many studies showing how important educational practices in nature are for children's health, development and learning. However, as in Germany and England, this practice implemented in Australia was also developed based on the practices made in Scandinavian nature schools (Sevimli Çelik & Yalçın, 2020). The practice in nature is usually in the form of a routine consisting of three basic practices: eating and drinking, circle and exploration time (www.education.vic.gov.au; 2020). Especially in times of discovery, the child is encouraged to explore nature with all his senses. However, care is taken to minimize the trace left in nature during this exploration. There is even a minimum impact guide available in the sources. It is seen that the guidelines determined in the minimum impact guide are actually directly related to the environmental education process for sustainable development (Sevimli Çelik & Yalçın, 2020 p. 89).

3. Garden-Based Education Approach

Garden based environmental education is an instructional strategy that utilizes the garden as a teaching tool. It encompasses programs, activities and projects in which the garden is the foundation for integrated learning, in and across disciplines, through active, engaging, real-world experiences that have personal meaning for children, youth, adults and communities in an informal outside learning setting.Looking at the foundations of the garden-based education approach, it is seen that the field of education is based on the most prominent philosophers and educators from Comenius to Dewey. The ultimate goal of the garden-based education approach is to bring "environmental awareness" to children (Morris & Zidenberg-Cherr, 2002; Tran, 2015). In this direction, environmental awareness for a sustainable world turns into an applicable process at all levels of

education. As a matter of fact, while children are learning with garden-based education, they are actually preparing for "real life" and gaining life experiences (Dewey, 1996). When we look at Turkey, the fact that the understanding of garden-based education is not adequately reflected in both education programs and practice from early childhood to higher education reveals that this approach is not included at the required level. Garden-based education is a good model for raising individuals who are both environmentally conscious and have environmentally responsible tendencies. It is also an important step for students to discover the natural environment they live in (Taşçı et al., 2020).

4. Place-Based Environmental Education

Place and community-based environmental education is accepted as desirable environmental education in today's world. In addition to carrying out teaching activities on the natural environment, it also takes its place in the literature as teaching how to create a natural environment. Place-based education is a relatively new term. However, progressive educators have supported this concept for over 100 years. For example, in "School and Society," John Dewey advocated an experimental approach to student learning in the local environment: "Experience outside of school has a geographical aspect, artistic and literary, scientific and historical aspects (1915, p. 91). It includes the traditional methodologies of outdoor education advocated by Dewey to help students connect with particular corners of the world.Proponents of place-based education often see it as having a role in ensuring local ecological and cultural sustainability.

Sobel, on the other hand, states that the infrastructure of this teaching process consists of subjects such as the aesthetics of the society and the environment, its history, folk culture, social problems and economy. It has been stated that one of the most basic goals in this process is to explain how nature, social infrastructure and culture interact and shape each other (Sevimli Çelik & Yalçın, 2020). Hence, it is multidisciplinary in nature. Today, in order for children to move more easily in the natural world they live in, it is important that they first get to know the 'place' they live in. In order for this to occur, it is thought that place-based education should be given to children effectively (Keşaplı Can, 2015). Smith and Williams (1999) describe this approach as "ecological education". The practice of ecological education entails seeing humans as part of the natural world and human cultures as the result of interactions between species and particular places.

5. Outdoor Education

Outdoor education relies on the assumption that learning experiences outdoors in 'nature' foster an appreciation of nature, resulting in pro-environmental awareness and action (Clarke & Mcphie, 2014). Outdoor education means learning "in" and "for" the outdoors. The ultimate goal in outdoor education is to complement and expand traditional classroom teaching; to ensure that structured environments are integrated with natural

environments and combined with meaningful contextual experiences. In other words, the main purpose of "outdoor education" is to provide meaningful contextual experiences in both natural and structured environments that complement and expand classroom teaching dominated by print and electronic media (Knapp, 1996). In the world we live in, children's chances for unstructured play and a regular connection with the natural world seem to be greatly reduced. Outdoor education programs are a tool that helps children reach the natural world. Outdoor education is an educational approach focused on curriculum, behavior, production, protection and survival (Shanely, 2006). Nature offers different materials to children in outdoor education. Children can learn a lot just by being in nature, using all their senses in the process, and exploring and examining nature (Dinçer, 1999).

6. Game-Based Education Approach

It is emphasized in the most important publications of institutions and organizations such as NAEYC- (Association for the Education of Young Children) that it should be game-based when creating programs in the education of children, especially when creating programs that center the child (Bredekamp & Coople, 1996; NAEYC, 2014). Considering the early childhood developmental characteristics, the game has always been the focus of attention for all stakeholders focusing on early childhood, in line with its uncanny effect on the regulation of learning experiences, the development and change of behaviors and attitudes (Ahmed et al. 2016, Bergen, 2002; Cabrera, 2017; Frost, 1988; Orr & Geva, 2015; Quinn et al., 2018). In this direction, in order to realize sustainable development in early childhood, environmental education experts consider games, especially outdoor games, as important evidence for developing environmental knowledge, awareness and positive attitudes towards nature in early childhood. As a matter of fact, it has been found that one of the situations that explains the positive attitude towards the environment developed by children who have nature-based play experiences in outdoor spaces in the preschool period is these play experiences (Ewert et al., 2005).

7. Environmental Education Approach

The environmental education approach, which was accepted in the early years of environmental education, aimed to learn the interrelationships of physical and social systems with each other. However, due to the fact that this approach remained highly technical and instrumental in the following process, it ignored environmental problems and left its place to the eco-pedagogical approach (Çelikbaş, 2016; Özdemir, 2007).Environmental education approach focuses on:1. Engaging with citizens of all demographics to;2. Think critically, ethically, and creatively when evaluating environmental issues;3. Make educated judgments about those environmental issues;4. Develop skills and a commitment to act independently and collectively to sustain and

enhance the environment; and,5. To enhance their appreciation of the environment; resulting in positive environmental behavioural change (Bamberg & Moeser, 2007; Wals et al., 2014).

8. Ecopedagogical Approach

The ecopedagogical approach has provided a pedagogical and critical perspective on environmental education and aimed to bring an understanding that includes respect for nature, people and diversity (Gronemeyer 1987; Kahn 2010; Okur Berberoğlu, 2015). An environmental education based on an ecopedagogical approach aims to teach the rules of life with an education based on the principles of ecology and to transform these rules into desired attitudes and behaviors (Atasoy, 2005; Gronemeyer, 1987; Kahn 2010; Okur, 2012).Ecopedagogy's primary goal is to create a "planetary consciousness" through revolutionary teaching and learning (Bowers, 2004).Ecopedagogy scholar Richard Kahn describes the three main goals of the ecopedagogy movement to be:

- •Creating opportunities for the proliferation of ecoliteracy programs, both within schools and society.

- •Bridging the gap of praxis between scholars and the public (especially activists) on ecopedagogical interests.

- •Instigating dialogue and self-reflective solidarity across the many groups among educational left, particularly in light of the existing planetary crisis (Kahn, 2010).

Gaard (2009) outlines the necessity for children's environmental literature to encompass the following core aspects of ecopedagogy;

Figure 1. Aspects of Ecopedagogy (Gaard, 2009)

The movement aims to create educational programs that interrogate the intersection of social, political, economic and environmental systems. As an outgrowth of critical pedagogy, ecopedagogy critiques environmental education and education for sustainable development as vain attempts by mainstream forms of pedagogy seeking to appear relevant regarding current issues of environmental degradation (Kahn, 2008).

9. Ecological Learning Approach

An education that considers ecology as the basic building block is the most effective method for individuals to learn information about the environment and science and to change their attitudes positively (Ozaner, 2004; Phenice & Griffore, 2003; Thoe and Lin, 2006). The ecological learning approach, which helps the individual to be aware of the environment and social environment in which he exists, emphasized that environmental education should lead the socio-cultural change and adopted the idea of "a new person, a new society" as a principle. The effectiveness of the approach has decreased due to the fact that the approach is seen as incomplete and inadequate in the academic context and does not take into account specialization (Çetin, 2018; Özdemir, 2007).

10. The Nature Experience Approach

Many theoretical and empirical research in the 1990s suggested an important role of nature experience for the development of environmental values and attitudes, as well as in influencing pro-environmental behaviors. In particular, evidence emerged those different kinds of environmental experience have a different impact on environmental behaviors (Bögeholz, 2010). This approach is very important in terms of environmental education and students' understanding of the relationship between living and non-living things based on their discovery of environmental events such as matter cycles (Özdemir, 2010; Özdemir & Uzun, 2006). In the figure below, five nature-related aspects (Bögeholz, 2010)to fulfil the requirements of nature experience dimensions are given;

Figure 2. Nature-Related Aspects to Fulfil the Requirements of Nature Experience Dimensions

Showing students how and in what way the intervention of human elements to nature through education in nature and the changes that occur due to these interventions will lead them to love and show more interest in nature. Among the conditions of nature education to be applied, features such as mutually establishing the relationship between the student and the environment, realizing active learning, entertaining and interesting in the learning process are included in this approach (Birinci, 2013; Bullock, 1994).

11. Educational Approach for Sustainable Development

Sustainable development aims to develop the many sustainable development goals approved by the United Nations that highlight a global vision for sustainability. Education institutions play a fundamental role in empowering individual reflection on one's own actions to foster current and future social, cultural, economic and environmental understanding and impacts (Barth et al., 2007) to activate participation both locally and globally and to reframe complex situations on a sustainable basis. Individuals are encouraged to reach sustainable development by defining new directions through active participation and societal cooperation (Jebrian et al., 2020; UNESCO, 2006).The framework of the approach consists of three different titles, which are mentioned as education about the environment, education within the environment and education for the environment (Mamur, 2017; Okur Berberoğlu & Uygun, 2013).
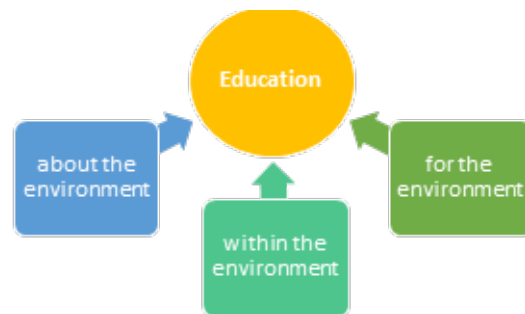
Figure 3. The Framework of the Approach for Sustainable Development Consists of Three Different Titles

It is an educational approach about the environment that aims to inform individuals about human-environment interaction, to explain cause-effect relationships in this direction and to increase their level of interest, and to develop more cognitive areas (Mamur, 2017; Tilbury, 1995). The approach to education within the environment, on the other hand, emerges as education based on student-centered activities rather than traditional methods and teaching methods that center out-of-class learning (Mamur, 2017; Tilbury, 1995). Today, it has become imperative for individuals to be conscious of environmental problems in education for the environment shaped by common points. In the approach based on the principle that the education given is mainly for the "environment", it is important for children to have basic knowledge about the environment and its problems,

to develop values based on protecting, improving and beautifying the environment, to define problems and to develop solutions (Ünal et al., 2001). Environmental problems increase day by day, the importance of early childhood in life and the need for children who grow up far from the natural environment to get to know nature increases the importance of environmental education in the preschool period.

Ecopsychology and Early Childhood Environmental Education Approaches Perspective

The term 'ecopsychology' was first used by Theodore Roszak in 1992. In his book, The Voice of Earth, Roszak (1992) discussed how human activities and the economic system have changed, and talked about the negative effects of these changing activities and economic order on ecosystems. By bringing together the principles of ecopsychology, ecology and psychology, it aims to help people become aware of their inner connection with nature and to repair the broken bond (Er et al., 2020). In addition, another aim of ecopsychology is to develop the ego about the environment and to mature the ethical responsibility of the person towards other people and other living and non-living beings on the planet (Uzunoğlu, 2006).

The aim of ecopsychology is to awaken the knowledge of the interrelationship of nature and man, which is innate and found in the ecological unconscious. However, ecopsychology aims to awaken this awareness in adults with the foresight that children's environmental awareness may be higher, by stating that the vital stage of human development is childhood. It is important to tell nature-friendly stories, fairy tales and lullabies for the development of environmental awareness in childhood. With the development of ecological consciousness, people have a sense of responsibility towards nature and other people, and ecopsychology aims to have this sense of responsibility have a say in social relations and political decisions (Enns, 2004).

Evaluation of Early Childhood Environmental Education Approaches in Terms of Purposes, Themes and Content

Learning occurs only when the subject is perceived by the child or student as related to them (Kola-Olusanya, 2005). Effective environmental education programs need to be personally relevant to the daily lives of children and young people and to what is happening in their "own backyard" (Ballantyne & Packer, 2009). It is important that the programs relate directly to the local context and give students the chance to "explore and experience their surroundings". Environmental educators must reintroduce students to their local area by exploring and experiencing, learning and celebrating. By doing this, environmental educators help students develop a sense of curiosity and a sense of place (Athman & Monroe, 2001). From this point of view, pedagogical approaches to environmental education contain different elements and principles. When the

relevant literature is examined, it is seen that these approaches are carried out with similar characteristics in different geographies of the world. Teaching environmental knowledge and developing important attitudes towards the environment are the most striking similarities. In addition, different perspectives were used in the evaluation of these approaches.

The importance of family role models is frequently mentioned in research (Arnold et al., 2009; Monroe, 2003). Having parents, teachers, and other role models that take an interest in nature can predispose people to take an interest in nature and then work to preserve it. Research shows that children are more likely to participate in environmental initiatives if their parents are also active in this way or approve and encourage them to participate (Chawla & Cushing, 2007).Many authors emphasize the importance of socializing and having fun while connecting with nature for children and young people. Young children naturally learn about the environment through informal, spontaneous, unrestricted play with others (White & Stoecklin, 2008).For older children, the chance to socialize and form friendships can be an important motivator to relate to nature and the environment (Arnold et al., 2009).

It is important for children and young people to be outside and use all their senses to actively explore, experience, make sense of their environment and have a sense of independence (Gurevitz, 2000). Research with environmentalists shows that "the most important school memories include opportunities for action rather than passive classroom learning" (Chawla, 1999). Research has found that most programs that show gains in young people's reported environmental behavior or intention to protect the environment also include an action component.

'Free choice learning' typically refers to learning that takes place outside of formal education (for example, through camping and walking in national parks and visiting museums, zoos and gardens). Through these experiences, 'the student exercises a great deal of choice and control over what, when and why they learn' (Falk, 2005). Some researchers stress the importance of focusing on these experiences as a way to foster lifelong learning and develop environmental understanding and responsible action. Gurevitz, 2000; Falk, 2005; Palmberg & Kuru, 2002).

There are many studies on the importance of encouraging children and young people to be active stakeholders in the environment and decision-making, especially from early childhood (Barratt et al., 2007). It brings a lot of criticism towards approaches that try to inform children and young people about environmental issues in the hope that it will lead to responsible action. Instead, many researchers advocate an approach that focuses on developing knowledge and understanding, empowering them, and a sustainable consciousness. To decide on environmental problems; planning and action, participation;

emotional response, critical thinking and reflection, and a sense of personal and civic responsibility (Athman & Monroe, 2001). The aim of this approach is for students to learn how to be active participants in society (Bolstad, 2003). Connecting children and young people to the environment in this way is defined as developing 'action competence' from early childhood (Breiting & Morgensen, 1999; Jensen & Schnack, 1997).

However, based on children's role as active citizens, many educators advocate the importance of children and young people having authentic experiences, being involved in real-life problems in the local context, exploring problems and taking action (Ballantyne & Packer, 2009; Monroe, 2003). In this way, real environmental issues at the local level help children practice active citizenship and see the effects of their contributions.

The themes discussed above are the dimensions that are thought to be in environmental education. Approaches to be used in early childhood environmental education need to be strong from some perspectives. It is seen that these approaches from the past to the present have different elements and different dimensions are emphasized. The table shows the themes emphasizing different approaches defined in early childhood.

Table. Comparison of ecological approaches to early childhood environmental education according to different themes

Theme / Environmental Education Approach	Giving children ecological knowledge	associating with daily life	Involving families, communities and role models	Providing opportunities for social connections	Encouraging direct experiences	Promoting free choice learning	Promoting the 'active stakeholder' role	Targeting real and local issues	Promoting collective benefit and action for the environment	Being eco psychologically based
Nature-Based Approach	✓	✓		✓	✓					✓
Forest Schools	✓	✓		✓	✓	✓				✓
Garden-Based Education Approach	✓	✓			✓					✓
Place-Based Environmental Education	✓	✓					✓	✓	✓	
Outdoor Education	✓	✓		✓	✓					✓

Game-Based Education Approach	✓	✓	✓	✓		✓		✓	✓	✓
Environmental Education Approach	✓	✓						✓		
Eco-pedagogical Approach	✓				✓				✓	
Ecological Learning Approach	✓						✓	✓	✓	
The Nature Experience Approach	✓	✓		✓	✓			✓		
Educational Approach for Sustainable Development	✓				✓	✓	✓	✓	✓	✓

As seen in the table above, providing children with ecological information and associating the learned information with daily life are the most obvious common features in the main goals of the approaches taken at the center. The least emphasis appears to be on promoting the 'active stakeholder' role and involving families, communities and role models. It can be said that the approaches that deal with the child in its entirety, support it in an eco-psychological sense and display a multidisciplinary content are approaches for game-based education and sustainable development. More objectives and themes are covered in these approaches.

Conclusion

In today's world where environmental problems are increasing rapidly, it is especially important to raise individuals who are sensitive to the environment and nature in order to minimize environmental problems. In this context, it is considered necessary to benefit from ecopsychology in terms of improving environmental awareness and changing human behavior against environmental problems. However, ecopsychology helps children become aware of their inner connection with nature and renew the degenerate relationship in early childhood, which is the critical period of human development. In addition, the importance of environmental education increases considerably in the context of prevention of ecological problems, development of ecological literacy, and awakening of positive environmental desire in children. Today, it is necessary to start environmental education from early childhood on raising children with high ecological sensitivity.

The use of traditional approaches and practices, in which the child is not at the center of environmental education and children are only included as passive listeners, requires

questioning the quality and effectiveness of teaching. Although an education based on pure knowledge transfer is not efficient for children, it is seen that most educators are content with framework programs and traditional approaches and practices, and especially children are not emotionally isolated in the process and cannot internalize the process. In this direction, it is possible to train children's negative attitudes towards environmental education in a positive direction, and it is possible with environmental education programs based on current pedagogical approach applications in a planned manner from early ages.

It is a teaching area of environmental education that is based on learning based on experiences and experiences. In order to achieve the objectives of environmental education, it is necessary for the efficiency of environmental education to include approaches and practices designed in a way that will contribute to children's motor skills, cognitive development, attitudes and perceptions towards the environment and be intertwined with nature. In addition, it is necessary to use out-of-class learning environments and outdoor activities effectively, and in this direction, it is necessary to turn to contemporary practices (Bulut, 2015; Demir & Yalçın, 2014; Özbuğutlu et al., 2014; Tanrıverdi, 2009).

When we look at the early childhood education historically, the child and nature have been considered as a whole since the early years (Duhn, 2012). According to Rousseau's reflections of nature experiences on child education and development, Froebel's pedagogical understanding (May, 2006) and early childhood educators of the same period (Burman, 1994), there is a strong interaction in the context of environment and children's education. Dewey also mentioned the importance of nature and natural materials especially in the education of children and states that being in close contact with nature contributes to both the development and learning of the child (Davis, 1998). In addition, thinkers such as Comenius, Rousseau and Pestalozzi in the 17th and 18th centuries talked about the importance of nature-based learning (Berberoğlu and Uygun, 2013). Comenius explains that while learning a subject, it is imperative for children to make contact with a plant, a stone or an animal in relation to that subject (Kanad, 1948).

It is important to give environmental education as well as the direction in which this education should be given is an issue that should be emphasized. A rich stimulating environment must be provided to effectively help children learn in the early years. Desired early childhood experiences help them develop positive attitudes towards school, learning and self-efficacy (Morrison, 2003; Oktay, 1999). In order to support early childhood development in the best way, an environment should be created in which children can gain more qualified cognitive stimuli, rich language interactions, and positive social-emotional experiences (MEB, 2013). It is essential that children grow up in an environment that keeps their interests and curiosity alive, especially in

early childhood. Children are always interested in discovering plants, animals, and other living and non-living things in the natural environment (Pramling & Samuelson, 2011). Environmental education to be conducted with children should declare in detail how natural systems work, the relationship between systems and the place of children in this relationship (Davis, 1998). In order to apply all these, outdoor activities should be used.

In line with the researches, it is seen that the studies on environmental education are mostly aimed at primary school and higher education children and adults, and there are very few and limited studies on children in early years. The common denominator in studies on environmental education in early childhood is that children's awareness of environmental problems, their knowledge, attitudes and behaviors about the environment develop, and people begin to attach importance to the effect of their negative behavior towards their environment. (Kurt Gökçeli, 2015).

It can be said that the approaches used in early childhood environmental education have similarities, although they are called by different names. Of these, it is important to understand the relationships between place-based education, outdoor education, and environmental education because each concept has been developed in some way by educators who produce curriculum materials and teaching practices that can be useful in other concept areas. What further complicates this potential exchange is the variety of labels applied to each of these approaches. For example, as the field of outdoor education matured, it was called school camping, camping training, and eventually outdoor training. Likewise, place-based education has been termed "community-oriented education", "ecological education" and "bio-regional education".

Traina and Darley-Hill (1995) expand 'local' to include 'bioregional education', encouraging students and teachers to know their place and consider the impact their lifestyles have on the resources of that bioregion. Similarly, Orr's (1994) call for "eco-literacy" offers principles for rethinking education that explicitly links place-based education with outdoor education. Accordingly, children should understand the implications of this knowledge for real people and their communities, and learn through direct experiences outside of the classroom.

Some critics of place-based education believe that the primary purpose of schooling is to prepare students to work and function in a highly technological and consumer-oriented society. In contrast, place-based educators believe that education should prepare people to live and work to maintain the cultural and ecological integrity of the places they live. To do this, people need to be knowledgeable about ecological patterns, causal systems, and the long-term effects of human actions on these patterns (Orr, 1994).

From this point of view, it can be stated that current pedagogical approaches used in environmental education and studies in the field of ecopsychology are limited. The

inadequacy of the studies on the approaches and practices that guided environmental education in the early years in the literature may cause the failure to achieve the desired success in environmental education and the failure to make environmental content updates a part of the system.These findings indicate that more research and practice is needed to develop approaches to environmental education that better reflect the child's own environmental experiences.

It is thought that studies should be carried out to measure the level of pre-school teachers' inclusion and consideration of current pedagogical approaches in environmental education at the stage of planning and implementing environmental and nature activities, and their interest, attitudes and self-efficacy towards these approaches. Subsequently, in-service training in the light of current data on environmental education may be among the suggestions. In addition, a mobile application consisting of video-supported activities can be created on the basis of contemporary applications that can guide families in order to make family participation studies effective and efficient in early childhood environmental education.

It can be recommended to increase the projects within the Ministry of National Education and universities to make the contribution of environmental education practices in early childhood to education more prominent and visible within the framework of current pedagogical practices and to increase good examples. In addition, environmental arrangements made in the light of the principles of ecopsychology in pre-school education institutions and their dissemination can be used to regulate the deteriorated relations of children with the environment.

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About Author

Elif Öztürk, PhD, is Assistant Professor of Early Childhood Education at Giresun University in Giresun, Turkey. She holds a PhD in Elementary Science education from Hacettepe University of Turkey. Her main area of interest are environmental education and inqiury based science education. Also she has interest about studies on children and science education. elif.ozturk@giresun.edu.tr

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Environmental Management as an Undergraduate Programme of Study in Nigerian Universities: Challenges and Prospects

Timothy O. Ogunbode
Bowen University

John A. Akande
Bowen University

Peter O. Ogungbile
Bowen University

Introduction

The modern term 'University' was derived from the classical Latin word, *universitas*, which means 'the totality' or 'the whole' (Verger, 1992a). *Universitas*, a name applied to diversified corporate bodies of the Middle Ages in Europe, also include the organization of teachers and students (Alemu, 2018). Alemu (2018) reiterated that the name had, through time, been particularly attached to the teacher-student corporate organization as *universitas literarum*, from which, particularly since the 18th century, the name University was derived. In another sense, Alemu (2018) stated that *universitas* had been a general term used in the medieval times to denote all kinds of community or corporate such as guild, a trade, a brotherhood, and so on. This, according to Alemu (2018), gradually culminates *universitas magistrorum et scholarium*, i.e. 'the university of masters and students' which stands for organized communities of individuals who were responsible for higher learning and study. Thus, a university represents both a higher learning institution and a community of scholars or persons. It is a higher learning institution that brings men and women to a high level of intellectual development in the arts and science, in the traditional professional disciplines, and also promotes high-level research. It also signifies a community of persons engaged in study and research. Thus, universities were established to pursue a set of goals, mission, functions and services (Assie-Lumumba, 2005), all of which depend on the needs and priorities of different societies (Alemu, 2018).

According to Paking (2007), the emergence of a university is premised on the relative advancement of civilization which necessitated for higher learning. Newman (1910) stated that 'University is a place where inquiry is pushed forward, discoveries verified and perfected, rashness rendered innocuous, and errors exposed by the collision of mind with mind and knowledge with knowledge. It is a place where the professor becomes eloquent, and also a missionary and a preacher displaying this science in its most complete and winning form, pouring it forth with the zeal of enthusiasm, and lighting up his own love of it in the breast of his hearers.

In the light of Newman's account, Alemu (2018) summed the meaning of university or higher education as a higher learning institution and academic environment where

a community of scholars engages in study (teaching and learning), research, and community services. He further added that it is also a center for professional training to serve society's socio-economic, political and cultural needs. From the ongoing, it is evident that it is not easy to give a straight-forward one sentence definition of University because it is differentiated in many ways. However, I feel that it is better understood when it is defined by virtue of its purpose and/or its functions. Thus, Alemu (2018) stated that universities can be seen in relation to education and scholarship through teaching, research and public services. Altbach (2006) and Boulton and Lucas (2008), observing the current background for establishing universities, corroborated this view by stating that, "a University is not an easy task, especially in this era of differentiation in higher education, with new and diverse institutions emerging everywhere", without explaining the common function, purposes and values. Also, Salmi (2009) and Tilak (2015) further revealed that the idea of a university stands for humanism, for tolerance, for progress, for the adventure of ideas and search for truths. It stands for the onward march of humans towards ever-higher objectives. Thus, it is evident that if universities discharge their duties adequately, then all is well with the nation and the people. Allen (1988), Newman (1996), Oakeshott (2004) and Toope (2014) also submitted that throughout history, universities have played three interlocking roles, but differently, at different times and in different places. These roles are teaching new generations; preserving and discovering knowledge; and constituting talent, ideas, advice and challenges to the wider societies. In an era of '*non-leux*' (non-place), universities are best placed to fulfill those roles today by resisting the pressures to uniformity and contributing to an intergenerational dialogue that requires diversity and disputation. In the light of the foregoing, Universities are usually organized into schools/faculties/colleges and departments around different fields of knowledge or around a specific instructional objective or mission. Autonomous (undated) stated that academic department is the basic administrative unit within the university organized to carry on and develop the instructional and research activities of its faculty. In furtherance, the faculty of an academic department shall include all those members of the university faculty who have been appointed to the department with the consent of other members of the department/faculty. The academic department shall have the fullest measure of autonomy consistent with its function and responsibilities within the college and the university, subject to the provision of the Charter establishing the University. Academic department is headed by a Chair appointed by the University Management. Universities are organized such that related programs are put together under same faculty/college which is most often premised upon the need to minimize overhead cost especially among private universities. It is organized in such a way that administrative overhead cost is grossly minimized. Boulton and Lucas (2008) and Jensen (2010) stated that Universities are organized into colleges which will be in charge of a preliminary degree and a number of professional schools which will provide the education proper- School of Medicine, Law, Engineering and so on. To this was added

researcher education in a School of Graduate Studies. The first universities to adopt this structure were Cornel and John Hopkin dating from 1868 and 1872 respectively.

In Nigeria, the establishment of academic programmes is the sole responsibility of National Universities Commission (NUC) while Joint Admission and Matriculation Board (JAMB) oversee admissions into universities and other higher institutions in the country. All the approved universities in the country are expected to seek through their proposals for the establishment of any academic programme from the NUC, which then schedule a visit for the initial Resource Verification and approval or otherwise. At the appointed time after approval, university writes the NUC for programme accreditation. This is intermittently done by the body to ensure consistent adherence and compliance to the approved laid down guides for any respective academic programme. Some of the departments being run in Nigerian universities under each Faculty/College include Faculties of Arts (Humanities), Engineering, Social and Management Sciences, Health Sciences, Administration, Law and Technology, each with its own respective academic departments. The autonomy of universities enable each university to organize its own academic units as it wishes as long as it is borne out of senate approval (the only body responsible for academic maters with the Vice Chancellor as its Chair).

Historical Background and Practice of Environmental Management Practice

The development of Environmental Management programme is not similar to other sciences like Physics, Mathematics, Biology, Chemistry, Philosophy, among others, in the sense that it is more of a recent science dated to early 60s and also, it was not clearly associated with ancient philosophers such as Aristotle, Alexander, Plato, and Socrates, among others. Despite this, the consciousness and the practice of environmental management is as old as human race as man had been in charge of his own environment in terms of the benefits derivable therein, its protection, conservation and its sustenance for his comfort (Dernbach, 2003; Pigou, 1920). Environmental Management combines the term "environment" and "Management". Environment as a concept is defined as "

Colby (1989) in his article titled "The Evolution of Paradigms of Environmental Management development revealed that "for centuries, a usually implicit debate has prevailed between what have come to be called "economics" and 'development' on one side, and the conservation of nature and 'ecology' on the other, at least in western civilization. In the past quarter century, as environmental management has become an increasingly explicit and significant matter requiring the attention of governments, this dichotomy has begun to break down. Thus, discussions have become serious on 'sustainable development', bringing about what environmental management and sustainable development entail. Thus, broad fundamental paradigms of environmental management in development are referred to as 'frontier economics', 'deep ecology',

'environmental protection', 'resource management' and 'eco-development'. According to Colby, there are overlaps between these paradigms: they evolved from societies' basic assumptions about the relationship between man and nature, and are therefore, related to each other. They are not completely distinct "species" but have implications for the future of environmental management.

By 1960s, especially after the 1962 publication of Rachel Carson's book, *Silent Spring*, pollution was a major concern in the industrialized nations. Scientists began to study "environmental problems", usually related to pollution or the destruction of habitats and/or species. The recognition of the pollution problem in the polarized context of frontier economics versus the nascent deep ecology schools led to the perception of the necessity to make compromises, or trade-offs; the constrained perception of "Ecology and Economic growth" became freshly explicit.

In the context of India, Das (2018) stated that economic development without due environmental considerations causes environmental crisis. Thus, management of both environment and natural resources in a country like India has become more urgent. He further stated that basic functions of good environmental management are goal setting, information management, environmental management, piloting, implementation and control, communication, internal and external auditing and so on. The implication of man's activities on his environment has called for a broadened environmental management.

In Nigeria, Obasi and Ogwuche (2016) revealed that environmental management education as an academic and professional discipline is relatively new though, evolving rapidly. Obasi and Ogwuche (2016) and Iyalomhe et al., (2017), however, lamented that thirty one (31) out of one hundred and forty one (141) Universities and other fifty two (52) degree/HND/NCE awarding tertiary institutions offer Environmental Management programmes. This is a gross dearth of professionals in this field to ensure sufficient tackling of environmental challenges. They, in addition, revealed that environmental education is one of the twenty-one (21) strategies of tackling environmental challenges.

Why Bachelor of Science in Environmental Management?

The need for the training of professionals in Environmental Management in Universities at undergraduate level is found in their various prospective. This contains the University name, School/Faculty/College name, philosophy and the duration as shown for some Universities in Table 1:

Table 1. Environmental Management Programmes in Nigerian Universities

S/N	University Name	Ownership	School/Faculty/College	Nomenclature
1	University of Agriculture, Abeokuta	Public	Agriculture	Environmental management and Toxicology
2	Michael Okpara University of Agric, Umudike, Umuahia	Public	Agriculture	Toxicology & Environmental management
3	Benson Idahosa University, Benin City	Private	Agriculture	Forestry/Wildlife & Environmental Management
4	Kogi State University, Anyigba	Public	Agriculture	Soil & Environmental Management
	Evan Enwerem University, Owerri	Public	Agriculture	
	Ebonyi State University, Abakaliki	Public	Agriculture	
	Crawford Univesity of Apostolic Faith City, Ogun State	Private	Agriculture	
5	Evan Enwerem University, Owerri	Public	Social and Management Sciences	Geography & Environmental Management
	University of Ilorin	Public	Management Sciences	
6	University of Benin, Benin City	Public	Education	Environmental Education
	University of Calabar, Calabar	Public	Education	
	University of Abuja, Abuja	Public	Education	
	Bayaro University, Kano	Public	Education	
	Abubakar Tafawa Balewa University, Bauchi	Public	Education	
	University of Maiduguri	Public	Education	
	Ekiti State University, Ado Ekiti	Public	Education	
	Niger Delta University, Wilberforce Island	Public	Education	
	Rivers State University of Science and Tech., Port Harcourt	Public	Education	

7	Anambra State University, Uli Abubakar Tafawa Balewa University	Public	Environmental Sciences	Environmental Management Technology
	N o v e n a University, Ogunme	Private	Environmental Sciences	
	University of Port Harcourt	Public	Environmental Sciences	
8	Nnamdi Azikwe University, Awka	Public	Environmental Sciences	Environmental Management
9	Abia State U n i v e r s i t y, Okigwe	Public	School of Technology	Environmental Resource Management
10	I g b i n e d i o n University, Okada	Private	School of Technology	Environmental Management and Control
	Ekiti State University, Ado-Ekiti	Public	School of Technology	
11	University of Calabar	Public	Management Sciences	Resource Management
12	Kaduna State University*	Public	Environmental Sciences	Environmental Management
13	C a l e b University**	Private	Environmental Science	Environmental Protection and Management
14	B i r m i n g h a m University***	Private	Environmental Sciences	Environmental Management

Sources: S/No 1-11: UTME Brochure, 2014; ***: Birmingham University Website (29/3/2020); **: Vanguard Newspaper website (29/3/2020)

*:Kaduna State University Website (29/3/2020)

Often, the introduction of any academic programme is usually premised upon the need of the society, among others (Perkin, 2007; Simon, et al., 2011; Ndlovu-Gatsheni, 2017). The approval of any new academic school/faculty/college is the sole responsibility of National Universities Commission in Nigeria. Such accreditation is usually on the basis of University meeting all the laid down guidelines with the belief that national interest and manpower needs are the top most priorities. Other conditions, according to National Universities Commission (2007, 2014), for accrediting a programme are as follows:

a. Philosophy and objectives of the programme.

b. Curriculum: the curriculum of the programme to be accredited should be adequate to prepare practitioners at appropriate level on a particular field;

c. Teaching staff, quantity and quality;

d. Student admission, retention and graduation requirements;

e. Standard of degree examination;

f. Financial support;

g. Physical facilities;

h. Administration of the Department and

i. Employers' rating of graduates.

Of all these conditions for effective take-off of any undergraduate programme in any approved University programme in Nigeria, at least, the criteria a, b, c, f and g are crucial to the commencement of any newly established programme. The remaining four criteria can be taken care of, while the preliminary activities are being carried out aftermath the commencement of the programme.

However, all the guidelines highlighted above are premised on the societal needs of the programme and at times, the prestige often attached to the running of the programme. For example, medicine and pharmacy. Apart from these, another salient condition that seems to be a powerful factor in establishing a new programme is the political will of the university management. It seems that when the management has keen interest in mounting an academic programme, all required resources will be made available for its take off. This fact seems to be peculiar to private Universities where the vested interests of possibly the University Proprietor, Council and Senate leadership influence the running of certain programmes in their respective Universities.

Bachelor of Science in Environmental Management in Nigerian Universities

For those keen to study a subject that touches many of the biggest challenges in the world today, Environmental Science degree is a good starting point. Environmental Science incorporates the study of the physical, chemical and biological processes that take place on earth as well as social, political and cultural processes which impact the planet. As an Environmental Science student, one will strive to understand the complex relationship between mankind and the environment, drawing on a diverse range of disciplines (topuniversities.com/course/environmental/studies/guide). The list of possible Environmental Science topics include but not limited to; Soil Ecology, Earth Systems, Environmental and Biological Conservation, Energy and Climate Change, Water Resource Management, Pollution Prevention and Remediation.

Scope of Environmental Science

Environmental Science is very much an interdisciplinary subject. Environmental Science degrees challenge students to combine skills and knowledge from a variety of different views. This could mean exploring aspects of Biology, Chemistry, Physics, Geography, Earth and Marine Sciences and Social Sciences like Economics, Law, Sociology and so

on. The idea is to combine multiple perspectives and data sources, to build up a fuller understanding of natural and human environment.

Fieldwork is an important part of environmental science degrees, which often includes trips to a variety of different countries and world regions given those who study environmental science the opportunity to experience habitat, climate, land formations and societies. Also, one is expected to spend a fair amount of time in the laboratory learning how to carry out different types of tests and analysis. In addition, students often undertake compulsory optional work in an environment-related role, which provides valuable experience to prepare them for future environmental science careers.

Interested in how best we can manage our environment, given the pressures that threaten its future and the design of more sustainable practices and use technology effectively, then The B.Sc (EM) is a MUST for anyone with an interest in this critical subject. Students shall explore the complexities of the natural and built environment; how our activities influence them both; and how they influence what we do, whether at home, in communities or in organizations. This interdisciplinary degree combines aspect of pure sciences, management, technology and social sciences to help students understand the environmental systems in which we live and work, and how we can improve the way we act within them. They shall gain the knowledge and skills needed to understand management of local, national and international environmental problems more sustainably as well as developing their analytical, design, and systems thinking skills.

Justification of B.Sc (Environmental Management) Programme

The global environmental realities and issues today, and the roles Nigeria is playing underscore the importance of this programme. The carbon credit and environmental threats that Nigeria and African Nations face as a result of susceptibility to natural upheavals speak to the need for this programme. These have social and economic implications. The programme, if allowed to be run in our universities undergraduate level, will increase the pool of persons in Nigeria who are qualified to contribute to the social and economic competitiveness of the country. The B.Sc (EM) shall develop broad and specialist skills that are in demand from government and regulatory bodies; the private sector, consultancies, conservation organizations and academic institutions. Careers directly related to the degree shall include;

1. Environmental Education

2. Planning and Sustainability

3. Environmental Management and Consultancy

4. Water Quality and Resources Management

5. Pollution Control

6. Waste Management and Recycling

7. Energy Management.

Apart from these, Table 2 shows several areas one could be relevant and actively engaged with B.Sc in Environmental Management

Table 2: Job Prospects for Environmental Management Graduates

S/N	Private Sector	Public Sector
1	Self employed	Lecturers in Federal and State Universities, Colleges of Education, Polytechnics and Research Institute
2	Consultancy jobs (e.g. United Nations, World Bank etc.).	Energy Parastatals e.g. Power Holdings etc.
3	Oil companies (e.g. Mobil, ELF, Shell, Chevron, etc.)	Oil and Gas – NNPC, Niger Delta Development Commission (NDDC).
4	Banks (e.g. UBA, First Bank, Union Bank, Access, etc.	Water Basin Development Authority (e.g. Anambra – Imo River Basin Authority).
5	Environmental Management Firms (e.g. Environmental Impact Assessment Services, Waste Management	Federal and State Ministries as Administrators
6	Transport Corporation (e.g. Land, Air & Sea)	Local Government Administration
7	Housing Estate Developers	International Organizations
8	Lecturers in Private Universities, Colleges of Education and Polytechnics	Rural Development Authorities
9	Business/Trade/Manufacturing Firms	Urban Development Authorities
10	Oil and Gas Servicing Firms	National Commission(e.g. INEC, Energy, etc.)
11	Political Parties Secretariat Administrators	Town Planning Authorities
12	Agricultural Services and Supplies	NESREA, Water Corporation Boards
13	Information and Communication Technology Companies (MTN, Airtel, Etisalat, etc)	Environmental Management Boards (e.g. Waste Disposal, Pollution Control etc.).
14	Construction and Engineering Company Administrators	Tourism and Sports Board
15		Information and Communication Technology (Nigeria Communication Commission)
16		International Non-Governmental Organization
17		Military and Defense Organizations
18		National Space and Meteorology Agencies
19		Federal and State Infrastructure Development Boards
20		Railways, Airports, Seaports, etc.

Source: Nwadiegwu and Iyi (2015)

The Philosophy of B. Sc Environmental Management Programme

The philosophy of the programme across universities is generally hovering around the

quoted National Open University of Nigeria (NOUN) philosophy: "to produce graduate who are environmental literate, sensitive and skillful. It also seeks graduates who can make objective contributions to national development by providing solution(s) to natural and man-made environmental problems arising from environmental abuse and make the surface of the earth to be functional habitable and sustainable. The justifcation of B.Sc (Environmental Science and Resources Management) in NOUN is thus "the environment has become a global issue as such: -students are provided with up-to-date information on environmental trends through the programme; - students are equipped with sufficient skills in the theory and practical applications.

Challenges of Environmental Management Programme at Undergraduate Level

Up till date, few universities run Bachelor of Science degree in Environmental Management programme at undergraduate level in Nigeria as shown in Table 1. While some use the nomenclature in conjunction with other older discipline, most especially, Geography, Soil and Agriculture, some others combine it with toxicology, an aspect of Chemistry programme. Also, such respective nomenclatures, at times, are to improve enrolment in the preexisting programme or as a new field of study. Thus, the programme only exists as Environmental Management in few universities in the country. Examples include Kaduna State University, Kaduna, Igbinedion University, Okada, Edo State and Nnamdi Azikiwe University, Owerri, Imo State. Thus, it is revealed here that most private Universities in Nigeria do not run Environmental Management programme at Bachelor degree level, apart from Igbinedion University. Bowen University is probably the only university that runs the programme at postgraduate levels, awarding Masters and Doctorate degrees.

The globe seems to be plagued by a catalogue of disasters that no one can stop. Environmental management is about coordinating these efforts- investigating problems, developing solutions and working in multidisciplinary teams to get things done. Environmental Management gives you skills and knowledge to find creative responses to environmental challenges.

Environmental Management is a multidisciplinary discipline involving knowledge of various aspects of subjects that influence the environment (University of Guelph, 2020). These include biological, chemical and physical activities. In addition, it encompasses the knowledge of economics, sociology, statistics, technology, law and cultural studies. In fact, a comprehensive approach to solving environmental challenges span through every aspect of human life- including religion, occupation, language and so on.

In view of the scope complexities embedded in Environmental Management subject matter, the programme has been seen as too much-involving for it to be handled at undergraduate level. Thus, some higher institutions of learning run the programme at

postgraduate level which will enable specialty among scholars. It is not surprising that limited specialists are available to tackle the enormous environmental challenges plaguing the global community. Nwadiegwu and Iyi (2015) had lamented that it is abysmally low that only 30 out of 107 universities and other 52 degree/HND/NCE awarding institutions in Nigeria offer environmental management education.

Apart from this, another challenge facing the running of Environmental Management at undergraduate level is lack of history. Environmental Management derives its curriculum from various disciplines that have history like chemistry, physics, geography, and economics, among others. Environmental Management is a discipline of modern era which has no trace to the ancient times or men of the olden days, though, it has been in practical existence through ages (University of Guyana, undated).

Inadequate knowledge of what the discipline can achieve and what it can offer to whoever pursues Environmental Management at undergraduate level is one of the bedeviling factors that hinder its existence in most Universities, especially in Nigeria. The assumption that the contents of Environmental Management are already being taken up by those disciplines from which it derives its curriculum is erroneous. These origins are specialists in their respective disciplines and not specialists in Environmental Management. A graduate of Physics is a specialist in Physics, even if he/she talks about environmental Physics; Chemistry graduates are specialists in Chemistry and not in Environmental Management, though, they may be made to teach environmental chemistry students some courses. This same thing applies to specialists in Biology, Economics, Law, Sociology, Ecology, even when involved in producing graduates in Environmental Management; they still remain specialists in their respective diverse disciplines and not in Environmental Management. Environmental Management graduates are equipped to holistically tap relevant knowledge in these diverse disciplines to tackle environmental problems.

Benefits of B. Sc Environmental Management Programme

From the foregoing, it is evident that mounting Bachelor of Science degree in Environmental Management in universities is crucial and desirable for the following reasons:

Firstly, it is cheaper employing a graduate of Environmental Management than engaging specialists in diverse disciplines in solving multifarious environmental challenges currently ravaging the entire globe.

Secondly, more specialists in Environmental Management will be available for engagement in tackling environmental challenges which postgraduate level may not be able to produce by reasons of their fewness and also, they may not be available since

they will be trained to handle more complex and higher challenges. Nwadiegwu and Iyi (2015), in corroborating this observation, stated that Environmental Management is a necessity and a vehicle that will carry the country to sustainable development.

Offering Environmental Management education improves the level of environmental education in the global community. Environmental Management curriculum is run in such a way that the subject matter, if introduced at secondary level, as being clamored, there will be relevant hands to handle it. Nwadiegwu and Iyi (2015) and Rauen, et al. (2015), in their separate observations, revealed that Environmental Management and Control education needs to be made necessary at both tertiary and pre-tertiary levels, if the perennial challenges prevailing human natural environment would be subdued.

Recommendation and Conclusion

The entire globe is currently plagued with various environmental challenges which seem threatening to human continued existence. These challenges include flooding, climate change, loss of biodiversity, erosion, acid rain, desert encroachment, land degradation, water quality, urban pollution, waste disposal, urban heat, landslide, population explosion, slum development, to mention but a few. All these challenges need to be tackled holistically to ensure that they are mitigated, if not totally eliminated. Such approach can only be accomplished through the engagement of graduates of Environmental Management who have been well grounded in both theoretical and practical aspects of the subject matter. The comprehensive curriculum of Environmental Management enables the graduates to work with other related professionals in proffering ways of making our environment worth living in. As a result of this, universities globally, public or private, may not have the choice in this regard than to ensure that adequate resources and moral supports are given to the running of B.Sc degree in Environmental Management, if their contributions to the solution of multifarious challenges in human environment will be visible to the world. This is, apart from other benefits that stand to be benefited at local, national and international levels.

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About Author

Timothy Ogunbode, PhD is a lecturer/researcher in environmental Management, hydro-climatology and water resources management and the application of Geographic Information in environmental resources analysis at Bowen University, Iwo, Osun State, Nigeria. He holds a PhD in Geography from the University of Ilorin, Ilorin, Nigeria. He also has interest in climate change studies, environmental sustainability. timothy. ogunbode@bowen.edu.ng

John Akande, PhD is a Professor of Environmental Management at Bowen University, Iwo Osun State, Nigeria. He holds a PhD in Environmental and Resource Engineering from the State University of New York, Syracuse, USA. His main areas of interest are Environmental management and Forest Industry Development. Email address: John. akande@bowen.edu.ng

Peter Ogungbile, PhD is a lecturer/researcher in environmental pollution and environmental chemistry at Bowen University, Iwo, Osun State, Nigeria. He holds a PhD in Environmental Management and Control from Bowen University, Iwo, Nigeria. His main areas of interest are environmental pollution and water chemistry. ogungbilepeter@ yahoo.com

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Towards Environmental Culture

Hélder Spínola
University of Madeira

Introduction

Environmental imbalances are far from being a new concern. As a problem that is dragging on, there is, necessarily, a whole context that gets worse, to the point that we have lost, in the last decades, all the opportunities to solve it, or at least to mitigate it, gradually and with the time needed to alleviate the discomfort that always comes with any change. The severity and extent of environmental imbalances require, today, a more immediate and consequent action. According to the World Health Organization, nine out of ten people in the world breathe poor air quality, and more than 7 million people dies every year due to air pollution (WHO, sd.). Atmospheric emissions resulting from the burning of fossil fuels reduce average life expectancy by more than a year, subtracting more than 230 million years from humanity annually (Lelieveld et. al., 2020). The latest report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an organization that brings together 136 countries, concluded that about one million species are threatened with extinction and that the rate of extinction is accelerating at a pace never before recorded in human history (UN, 2019). On average, since 2014, an area corresponding to the size of the United Kingdom has been deforested and the rate of destruction of primitive tropical forests has increased by 44% (NYDF Assessment Partners, 2019). The production and dispersion of plastic is so high that it is already present in the form of microplastics in the food we eat, in the water we drink and in the air we breathe, which may represent the intake of two hundred and eighty plastic microparticles per day (Dalberg Advisors, 2019). As a corollary to these and many other environmental imbalances caused by mankind, climate change emerged, a problem which has not been taken into account in time and properly by the international community, forcing our goals to be set far below what would be necessary for its effects to be negligible.

Nevertheless, the profound imbalances that humanity is causing on the Planet are relatively recent. Only 50 years ago, humanity did not consume more resources or generate more pollution beyond the measure that the Planet was able to bear. Since the 1970s, humanity's ecological footprint has been larger than the Earth itself, reaching the point where, before the beginning of August, we have already consumed resources equivalent to those that the Planet can produce until the end of the year (Earth Overshoot Day, 2019). Regardless being a history with few decades, the path to global environmental imbalances begun to be traced a long time ago, through the way we have conceptualized

our relationship with nature and the use we have made of technologies and knowledge.

How did we get here?

The human species, like any other, emerged from the evolution of life on Earth and, in spite of all the guise that civilizations surround themselves with, it remains a biological reality and dependent on nature, manifesting an intrinsic need in maintain that connection (Wilson, 1984). The survival of human populations has always depended on the resources obtained from the natural environment and, although it now has an enormous technological capacity to explore, process and transform these resources, most of the time in its history and prehistory, humanity has lived as any other species, closely dependent on the direct conditions and provisions of nature (Shennan & Kevan, 2007). As human populations became equipped with technology and knowledge, they felt less and less submitted to the laws of nature and, with that feeling, positioned themselves on a higher and outer level. The Judeo-Christian culture is very revealing of this cultural and conceptual distancing, being a clear evidence of this vision the biblical passage of the book of Genesis found in verse 28 of chapter 1, referring to the words of God after the creation of women and men: "God said to them: be fruitful and multiply and fill the earth and subdue it, and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on the earth." These writings were developed a few thousand years ago (Mazar, 1969), but it already reveals the human position in relation to the rest of nature, considered hierarchically inferior and merely instrumental.

The environmental imbalances that affect us today result from the exploitation of resources and emission of pollution far beyond the Earth's capacity to replace and purify it, respectively. For a long time, a large part of humanity has adjusted its cultural mentality to explore nature far beyond its limits and balances, but it was only in the last half century that it had the dimension and sufficient technological capacity to reach that level. And only after arriving here and feeling the consequences of its actions is that we begin to realize that, after all, we are not above the laws of nature and its limits. Despite this, and of all the evidence, humanity has not yet retreat on the path of unsustainability it has been following, nor does it show clear signs that it will soon.

The role of Environmental Education

Currently, we are facing an ecological crisis in which climate change, deforestation, air pollution and the scarcity of water resources are just some examples of the enormous volume of consequences that affects us due to our inability to respect natural balances (Lumsden, 2018). Faith in technology to manage this terrible threat is not enough, even because we can't forget the intimate relation between its development and the escalade of environmental problems. We need a cultural transformation in the way humanity relates

to nature, and this can only be achieved through education (Plumwood, 2002). Indeed, promoting environmentally literate citizenship is the main purpose of environmental education, which is essential to achieve an improvement in environmental quality (Disinger & Roth, 1992). The concept of environmental literacy includes a wide range of aspects, namely knowledge and understanding of environmental concepts, problems and issues, a set of cognitive and affective dispositions, and a series of cognitive skills and competences, together with the appropriate behavioral strategies for implement this knowledge and understanding in order to make effective and relevant decisions in different environmental contexts (Cook & Berrenberg, 1981; Hollweg et. al., 2011; Hungerford & Volk, 1990; Simmons, 1995; Stern, 2000). In a simple way, we can say that knowledge, attitude and behavior capture the most essential aspects of environmental literacy (Hallfreðsdóttir, 2011; Igbokwe, 2012; Krnel & Naglič, 2009; Kuhlemeier et. Al., 1999; McBeth & Volk, 2010; Pe'er et. Al., 2007; Spínola, 2015), but in order to better reveal the complexity and interdisciplinarity of this concept, and the difficulties that face its promotion, it will be worth deepening it. Among others, knowledge must include physical, ecological, social, cultural and political systems, disposition must involve sensitivity, attitude, personal responsibility and motivation, skills must imply the ability to identify, analyze, investigate, evaluate and resolve environmental issues, and environmentally responsible behavior must include eco-management practices, persuasion, consumer action on the economy, political action and legal action (Hollweg et. al., 2011). However, despite the great effort that, around the world, has been put in environmental education, the ecological crisis has only worsened, leading some authors to question the effectiveness of the strategies followed (Blumstein & Saylan, 2007; Spínola, 2014). As so, and considering the time we no longer have for social and economic transformation that can rebalance humanity with nature, it becomes clear that we need to look for more effective paths than those we have been following in past decades.

How to Promote Environmental Literacy

Since the beginning, when the bases for environmental education were laid in the Belgrade Charter (1975) and in the Tiblisi Declaration (1977), good practices to be followed in the promotion of environmental literacy were established, aspects that were deepened and largely confirmed over decades of research (McComas, 2014). Despite the clear guidelines, the environmental education that crystallized, and in many cases that was lacking, assumed a clear tendency of divergence with its foundations, having largely turned into an inconsequential folk exercise. Despite the concept of environmental literacy emphasize knowledge, attitudes and behaviors, it has been evidenced, through studies in different populations and contexts, that the mobilization for action is not directly related to the levels of environmental knowledge, or even of attitudes, being dependent

on a multiplicity of factors that interact in a complex and socially contextualized way, which can start in the logistics and available systems (e.g. public transport, selective collection systems), go through the influence of the social norms, the feelings of shame or responsibility, the aspects intrinsic to the personality of each one or their socioeconomic level, until reaching the simple fact of having, or not, the knowledge on how to proceed (Newell et. al., 2014). Thus, the effectiveness of environmental education in promoting environmental literacy will never be enough if we continue to insist only on knowledge, on decontextualized initiatives and on focusing on the individual to the detriment of the community. Promoting environmental literacy requires the integration of a set of factors that interact with each other in a complex and, to a large extent, unknown way. As so, environmental education will always be more successful if it is developed in real socio-cultural contexts, betting on social dynamics rather than individual ones, and going far beyond the walls of the school and not allowing itself to be calibrated by age or generation. It must work to solve real environmental problems and accompany us throughout life, betting on a social and cultural learning strategy (Spínola, 2016). Ultimately, despite the complexity of the concept and the mechanisms that foster it, the promotion of environmental literacy must be, above all, a driving force for a profound cultural transformation capable of returning us to nature and reestablishing the balances that we have corrupted.

Culture and Nature

Understanding it in the light of its first definition, from the English anthropologist Edward Tylor, in his book Primitive Culture, published in 1871, 'culture' is a complex system of codes and standards shared by a society or social group and manifested in the norms, beliefs, values, creations and institutions that are part of the individual and collective life of that society or group (Tylor, 1871). Following the anthropocentric trend of human civilizations, the concept of culture has been asserting itself as something that distinguishes us from the rest of nature and opposes us to it (Read, 2012), ignoring in most cases that cultural diversity is, in fact, a consequence of the different environments in which the respective populations have been settled (Terray, 2010; Spínola, 2020).

Thus, the relationship between culture and nature reveals a paradox that is defined by the contradiction between the factual reality of interdependence among them and the anthropocentric view of both concepts being apart. Even when it is said that culture is what makes us human, distinguishing us from other animals, we must not forget that other species, particularly primates, also reveal their cultures, even if we want to classify them as rudimentary (Melo, 2012; Read, 2012). In this way, however much we want to distinguish ourselves and affirm in relation to the rest of nature, the reality of the human species can only be factually understood as its continuity. Humanity, and all that it does and creates, is also nature.

Despite being so obvious, or perhaps because of that, the study of the relationship between cultures and nature has only deepened in recent decades, bringing to light the concept of 'cultures of nature' and revealing that what we consider to be natural, the value that we give to it and the way we understand it, varies culturally. On the contrary to what it may seem, the way we understand nature in each culture is not a minor question, as it is that vision that determines our relationship with it, namely through the legislation we pass and the institutions we create, among many other aspects that determine our environmental impact (Head, 2017). The concept 'cultures of nature' arises to deconstruct the separation between nature and society, very present in modern Western cultures, and to highlight the interrelationship and connection between the human and the non-human world (Ares-López, 2017). This concept is defined as clusters of beliefs, practices, and assumptions, historically and geographically situated, underlying the relationship between people and non-human living organisms or inanimate matter. Thus, everyone is imbued with a certain culture in the way they are socialized to think and act on the territory and natural life (Ares-López, 2017; Head at. al., 2005). Necessarily, the different human communities reveal different cultures of nature and, while in some a more spiritual and ecosystemic view still remains, in westernized societies a utilitarian view of the environment predominates, as a source of resources to be explored. Claude Lévi-Strauss characterized well this context, concluding that the primitive societies of hunter-gatherers, and even of farmers and shepherds, reflected in their ideology the fact that they were strongly dependent on nature, seeing it not as their property, but as a spiritual territory that, in addition to nourishing them, also allowed contact with ancestors, spirits and gods. The first act of mutilation of the human species over nature was its own separation, a gradual process strongly influenced by most monotheistic religions, the Discoveries, the Industrial Revolution, the growth of cities and the scientific and technological revolution, and globalized with the expansion of Western civilization (Lévi-Strauss, 1973; Lévi-Strauss, 1976; Terray, 2010;). Surpassed the feeling of belonging to nature, and equipped with powerful technological tools, most of humanity felt entitled to intensively explore the environment in the light of immediate interests, which was quickly translated into the global imbalances that are quite evident today.

Another important contribution to our understanding of the human-nature interaction, was the theoretical approach developed by Julian Steward (1955), which he coined as 'cultural ecology', meaning the cultural changes caused by the need for environmental adaptation. In this context, assuming that culture is superorganic, he defended that cultures, not individuals, adapt. In fact, later, under the umbrella of a new concept, the ecosophy or ecophilosophy, Félix Guattari (1992) stated that without modifications to the social and material environment, there can be no change in mentalities, which make me think that environmental education needs to go far beyond an individual approach, and compromise further with social and cultural changes.

Environmental Culture, the New Approach Needed

After decades of marked widening of environmental imbalances, despite the scientific knowledge and technological tools available to alleviate them, and despite the profound effort made in environmental education, it is increasingly clear that the basis for promoting environmental sustainability lies in a cultural transformation of modern societies. Indeed, it has long been known that the ecological crisis we are experiencing is a consequence of human activities, which are strongly determined by the cultural characteristics that define communities (Head et. al., 2005). It is our beliefs and values, as well as the way we organize and function in society, that determines the heaviness of our activity on the environment. When it is intended to adapt human activities to the need to maintain natural balances on the Planet, it is mandatory to provoke cultural changes in communities and societies, in specially those that are ruled by a predatory extractive model. The ecological crisis requires, in addition to more environmental literacy, a profound social transformation, focused on the community, its organization, functioning, values, norms, economic model and, among others, lifestyles and life expectancies. On the other hand, the promotion of environmental literacy, for many reasons, has had great difficulties to bring about the profound changes that the reality demands, focusing on the individual in the detriment of society, and leaving essential aspects in a marginal position, such as reducing consumption, increasing public and private investment in clean technologies, increasing demands in regulation and supervision, changing lifestyles and expectancies, changing the economic model, and, even, reformulating the functioning of society. Thus, in order for environmental education to be better aligned with the degree of social transformation imposed by the environmental crisis, it is proposed that, in addition to environmental literacy, its objectives should be committed also with the promotion of an environmental culture.

When we search for 'environmental culture' in the international western literature we just found it occasionally, the same happening for other expressions that could be understood as synonymous, namely 'ecological culture' or 'eco-culture'. One of these few examples is the book 'Environmental Culture: The Ecological Crisis of Reason', published in 2002 and wrote by Val Plumwood, an Australian, philosopher and ecofeminist (Plumwood, 2002). Although she does not elaborate on its meaning, she leaves an important framework that aligns the concept of 'environmental culture' with the idea of being the only possible way to overcome the environmental crisis in which humanity is involved. Noting that, at the level of knowledge and technology, mankind already has the means to find the necessary solutions to be in balance with the Planet, Val Plumwood concludes that, in order to overcome the ecological crisis, it is necessary to develop an environmental culture that values and recognizes the entire non-human context and how much we depend on it, and that will allow to make good decisions about how we live and impact

the non-human world. Val Plumwood explains the adoption of the 'culture' concept as a way of integrating the necessary depth, breadth, and multiplicity of changes that the ecological crisis requires, and to mark a contrast with the strategies for imposing top-down solutions. Other of these rare references for 'environmental culture' was published in 2015 by Ingmar Schumacher in the context of environmental economics. Defining it as the type of culture that forms an attitude of care for nature and its resources, and adding that it is a specific type of culture associated with how mankind treats the Planet, he concluded that the 'environmental culture' emerges as a response to social needs, and not only helps to further appreciate environmental quality but, in addition, to reduce the consumption and, thereby, increase environmental quality. Also, the European Environment Information and Observation Network (Eionet), a project supported by the European Environment Agency, defines 'environmental culture' as "the total of learned behavior, attitudes, practices and knowledge that a society has with respect to maintaining or protecting its natural resources, the ecosystem and all other external conditions affecting human life" (GEMET, s.d.). Although this definition is deeply anthropocentric, placing natural resources as "its", that is, belonging to human society, and nature/environment as "external conditions" to human life, it worth mentioning since it is one of the strangely scarce references that contributes to institutionalize the expression in the context of the European Union.

When we search for this terminology in other European languages, namely French, Spanish, Italian, Deutsche or Portuguese, the reality is quiet similar. For example, in Portugal the expression 'environmental culture' is applied only once throughout the National Environmental Education Strategy, approved by the Portuguese Government in 2017 (Agência Portuguesa do Ambiente, 2017). In that same year, the Portuguese Government launched a call for proposals on environmental education activities and named it "supporting a new environmental culture" (Fundo Ambiental, 2017). Despite in neither of these two examples the concept of 'environmental culture' was defined, it was important references for its future institutional integration. Coincidentally with this reality in the western literature, the use of the expression on the public and political speech is also quite rare.

But all this context changes when we search for 'environmental culture' and, specially, 'ecological culture', in Russian literature or published by Russian researchers. Here, we found a deep and vast literature around this concept, not always perfectly aligned with the idea of the 'environmental culture' we defend, but with several definitions and reflections on its relevance to tackle the ecological crisis. In fact, in some works the ecological/ environmental culture is presented with a quite similar definition as environmental literacy (Kamakhina et. al., 2018; Shishkina, 2008; Simonova & Varnikova, 2015; Stukalyenko, 2015;), but in others with a more advanced understanding, including an

all society transformation (Tregubov, 2012; Sabrekov, 2020).

Kapto and colleagues (2019) set that both foreign and Russian thinkers are unanimous in considering that the present ecological crisis results from our inability to reconcile the scientific and technical progress with nature balance. However, they observe that many western scientists were looking for an explanation and solutions on the natural essence of the individual, while their domestic researchers, on the light of the Marxist tradition, are looking on the socio-historical and cultural context. In fact, western bibliography on the goals of environmental education is massively based on the environmental literacy of each member of a society, believing that the set of changes made by individuals will, as a whole, result in the solution to the ecological crisis, or, at least, force them. On opposition, many Russian researchers, as well as others from the former USSR and Asian countries, are also focusing on the dynamics of society, namely their organization and values, embodying this approach in the concept of ecological or environmental culture. Thus, despite, as we mention above, many eastern authors give to ecological/ environmental culture the same meaning as western authors give to environmental literacy, the formers also have been using this concept to include not only the individual but specially the society. For example, in Shilin (2000) an ecological culture is defined as the whole system of positive relations between human society and nature, being the means by which society regulates its behavior towards nature, being constituted by a system of goals and values in order to regulate the transition from a negative to a positive relationship between humans and living nature. Ridei and colleagues (2014), from the National University of Life and Environmental Sciences of Ukraine, considers that the purpose of the ecological culture is to guarantee a relationship between society and nature in order to achieve our practical needs but maintaining the nature stability on its own normality and, thus, preserve the conditions for the existence and development of mankind. They add that ecological culture is a survival ethical and moral imperative of ecological commandments for society and individuals. Glazachey, cited by Tregubov (2012), defines ecological culture as a combination of spiritual values, principles of legal norms and needs, ensuring the optimization of the relationship between society and nature, and considers that it is becoming a sociocultural phenomenon. Another interesting approach was the one made by Titov & Fufagin (2016), which, considering the evaluation of the environmental/ecological culture of a particular social system, stresses the importance of the society, not only individuals, in the concept. Titov & Fufagin distinguish the environmental/ecological culture of a particular social system from those considered for a population, justifying this approach with the need to include in the research the priorities in the political, educational, informational, ethical, aesthetic, and spiritual spheres of human activity. Also, a definition of 'environmental culture' can be found on the Ecological Portal of Saint-Petersburg, the Russian city on the shores of the Baltic Sea, a portal developed by the Committee for Nature Use,

Environmental Protection and Ecological Safety, a sectoral body of the executive power of the federal district (Ecological Portal of Saint-Petersburg, s.d.). With the title "Environmental culture- Raising of public awareness on environmental issues in St. Petersburg", 'environmental culture' is presented as being inherent in the national cultures of all humanity and defined as a social system of relationships, material values, norms and forms of interaction between society and the environment. This text also adds that "environmental culture is an inherent part of the pan-human and national cultures. It includes a system of social relations, material values, norms and ways of interaction of the society with the environment. It is continuously formulated in the public conscience and behavior through lives and activities of generations by permanent ecological education and enlightening; it facilitates the healthy way of living, spiritual development of the society, sustainable social and economic development and ecological safety of the society and people".

Recently, Sabrekov (2020) delineated a clear picture on what did happens to environmental education along the past fifty years. Considering that the concept of 'environmental/ecological culture' emerged in the 1970's through the work of the cultural researcher Lev Kogan, Sabrekov regrets that, with the advent of the industrial society in the 1980's, it suffered a distortion with the 'environmental/ecological culture' concept being eclipsed by the environmental education itself as an entity/concept. Later, environmental education became science-centered, and ecological culture becomes to be based only in scientific knowledge. However, Sabrekov considers that, presently, it is clear for the world scientific community that the environmental crisis can't be solved only by technical means, which demands for a revision on the environmental education approach. This Sabrekov statements could explain why, even in eastern countries, there was a clear distortion on the practices of the environmental education, aligning it in the individual and technologic spheres despite the social amplitude that was given in its foundations in the 1970's. However, more than a decade ago, Andreyev (2009) identified a change under the influence of the modern ecological crisis, stating that, at the time, people begin to understand the environment not by itself but in its relationship with society, and adds that, to overcome the present ecological crisis, an enhancement on the society's ecological culture is required.

Conclusion

The emergence of the ecological crisis poses challenges never before seen for humanity. Our species (*Homo sapiens*) has existed for over 300 thousand years (Hublin et. al., 2017) and throughout (almost) all this time lived in perfect harmony with nature, considering itself part of it. However, the last 200 years (less than 0.07% of its entire existence) were enough to change this reality, making human activity incompatible with ecological balance and, in the long run, with its own existence. On the one hand,

technological development, with less burdensome solutions for ecosystems, and, on the other, environmental education processes, as a tool for promoting environmental literacy, have been presented for almost 50 years as the path to re-establishing the balance between human activities and nature. However, over time, these strategies have proven to be insufficient, with environmental imbalances increasingly accentuated in a world broken by high levels of extraction and pollution. Bearing in mind that this outcome is a consequence of profound social changes, which began more than 2,000 years ago in the dominant human communities, it is unrealistic to admit that it is possible to change the paradigm without profound attention and action at the cultural level, changing the vision, activity and organization of our societies.

As a sign of reorientation of the strategy that has been followed in recent decades to face the ecological crisis caused by humanity, and as a way of gaining efficiency and giving depth to the necessary social transformations, it is proposed as a new and more complete challenge of environmental education (at the formal, non-formal and informal level) the promotion of ENVIRONMENTAL CULTURE. Not advocating divestment in promoting environmental literacy, but understanding that it is very much imprisoned by the individual spheres, with little influence in the social, political and economic transformations that are required, the proposal to compromise environmental education with environmental culture seeks to take root deeper in society and to meet the true dimension and urgency of the solutions and necessary changes in view of the seriousness of the problem that humanity and the Planet face. Thus, as a contribution to start this new path, a clarification is proposed in the definition of the concept of Environmental Culture, understanding it as a complex system of codes, standards and forms of organization shared by a society, or a social group, learned through education and socialization, and that contributes to the maintenance of environmental balances. It manifests itself through norms, beliefs, values, concepts, knowledge, habits, practices, expectations, lifestyles, institutions, and models of social and economic organization that, as a whole, ensure the environmental sustainability of a community. Although the concept of 'environmental culture' needs to be deepened and clarified, especially in the Western and international bibliography, we understand that it will emerge as the ecological crisis itself worsens, reflecting the need for a deeper transformation in society, which goes far beyond the changes and individual choices associated with the promotion of environmental literacy that, in recent decades, has imprisoned environmental education. In order to make it more consequent and effective, it is proposed that environmental education redirect its methods and objectives in order to add to environmental literacy the development of environmental culture, essential for building a society committed to natural balances and sustainability.

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About Author

Hélder Spínola is currently an Assistant Professor at the Higher School of Technology and Management and a Researcher at the Center for Research in Education, both at the University of Madeira, Portugal. He holds a Degree and a PhD in Biology and since the past fifteen years he has been focusing its research on the effectiveness of environmental education in promoting environmental literacy, especially environmental best practices. Recently, he started to drift its attention to a most social approach of the environmental education, most based in cultural transformations. At the University of Madeira, he coordinates some environmental education projects such as the 'Eco-School Program' and the 'One Family, One Planet' and teach several disciplines, such as 'Environmental Education' and 'Environmental Management Systems'. E-mail: hspinola@uma.pt. ORCID ID: https://orcid.org/0000-0002-6455-1595

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SECTION 2
SCIENCE EDUCATION

Evaluation of TIMSS 2019 and PISA 2018 Science Findings in Turkey Perspective

Sema Aydin-Ceran
Selcuk University

Introduction

In the 21st century, we are in a period where new reforms are introduced in schools and education to meet the social and economic needs of students and society. Organization for Economic Co-operation and Development (OECD) (2018) expresses this new understanding as creating a "new normal" in education in its "Future of Education and Skills 2030" report. In the same report, it is emphasized that an innovation made in the past is now commonplace, and an innovation made in the present will be normalized in the future (p,14). The 21st century differs greatly from the 20th century in terms of the skills people need for work, citizenship, and self-actualization. For example, computers and telecommunication constantly improve the capability to perform human tasks and constantly change the job types available to humans. Looking from the OECD point of view, "How can we prepare students for jobs that have not yet been created, to tackle social challenges that we cannot yet imagine, and to use technologies that have not yet been invented?" (OECD, 2019a, p.5). And "Students need support in developing not only knowledge and skills but also attitude and values, which can guide them towards taking ethical and responsible actions. This draws attention to the active role of a science literate society in shaping the future. In the 21st century, science literacy has become the basic step of the science education paradigm and the prerequisite of science curricula. One of the most important driving forces in revealing these inferences is the international education indicators that provide a data-based evaluation of the education systems and outcomes of the nations. Determining the performance of the students and the related variables have an important place in educational research (Yildirim & Aybek, 2019). It can be said that the most important studies to shed light on the science education of countries in the international context are the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). In this article, findings related to science achievement in Turkey testament will be evaluated in light of PISA and TIMSS and interpreted within science education policies.

What Do PISA "Science" Findings Say for Turkey?

PISA, which is held every three years since 2000, and which is necessary for 15-year-old students to take an active role in society, is international educational research that evaluates students' reading comprehension and competence in, Science, Mathematics, and different innovative fields. PISA stands out as an international indicator of education by ensuring the participation of countries that make up approximately 90% of the world

economy. The OECD defines the PISA survey not only as a comprehensive and reliable indicator of students' abilities but also as a powerful tool that countries can use to adjust their education policies (OECD, 2019b). Within this framework, OECD bears evidence of being the best policy and practice to help countries provide the best possible education to all their students. 2018 findings in Turkey regarding science, which is a dimension of the PISA research, show that students have a score below the OECD average. While Turkey is ranked 39th among 79 countries taking part in the research, it ranks 30th among 37 OECD member countries in science achievement. The science performance trend of Turkey in the PISA research between the years 2006-2018 is shown in Figure 1.
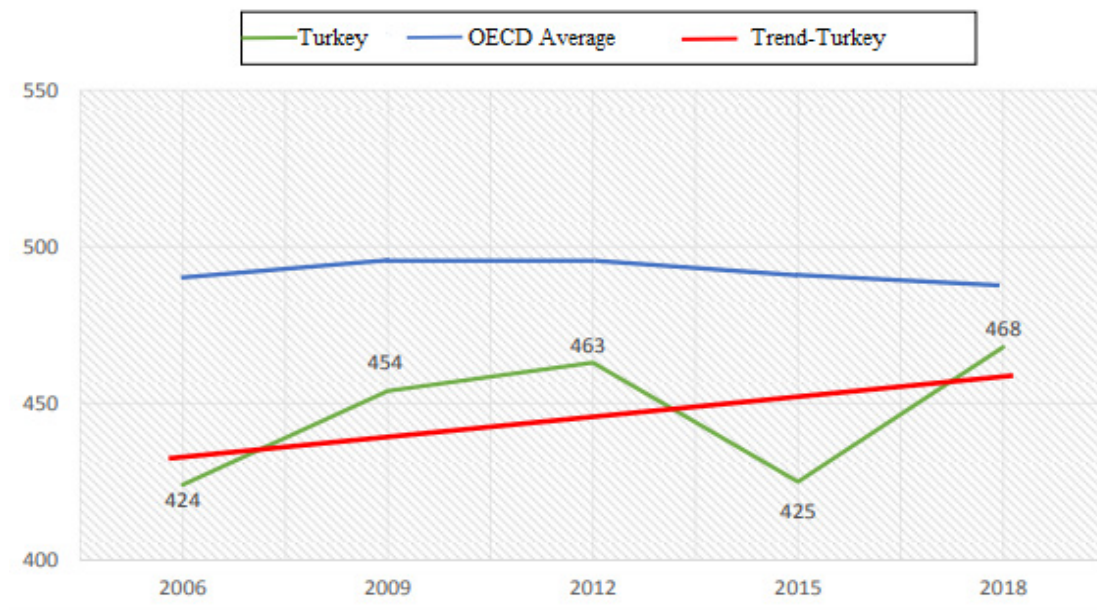

Figure 1. Science Performance Trend between 2006-2018 (Turkey)

When science scores since 2006 are examined, it can be said that Turkey achieved an increasing trend until 2015 but experienced a serious crash in 2015. 2018 findings show that we have reached a score band close to the 2012 science scores. According to the PISA report, PISA 2015 results–which were considerably lower–are "abnormal, and neither the decline between 2012 and 2015, nor the recovery between 2015 and 2018, reflect the long-term trajectory" (OECD, 2019c, p.3). In summary, Turkey's tendency to fluctuate over the years reveal a limitation to make clear predictions for the future. However, 2018 findings show that there is a decrease in the rate of students who fall below the basic proficiency level in science compared to previous years, and that there is an increasing trend in the rate of high-performing students. As a matter of fact, OECD (2019c, p.4) states that Turkey's tendency for science (2006-18) is positive. From the Science Education perspective, OECD emphasizes students' ability to think scientifically and to be a "reflective" individual, referring to their ability to comprehend science-related issues (OECD, 2019b, p.27). The concept of being a "reflective" individual here refers to a scientifically literate individual. In this context, PISA focuses on students'

competency in scientific literacy. Scientific literacy means knowledge and understanding of scientific concepts and processes necessary for personal decision making, participation in civic and cultural affairs, and economic productivity (Turiman et al., 2012). NCREL (2003) reinforces scientific literacy by the question; "Do students have the knowledge and understanding of scientific concepts and processes required for personal decision making and participation in social systems?". As for PISA, beyond knowing science concepts, science literacy focuses on the extent to which students can creatively use this conceptual knowledge in different contexts they encounter (daily life situations, past and present situations, and problems) and in real life (OECD, 2019b). In short, the focus is on what the student knows and can do. In line with this focus, the questions consist of seven proficiency levels. According to OECD data, the ratio of 2018 science scores in Turkey based on proficiency levels are presented in Figure 2.

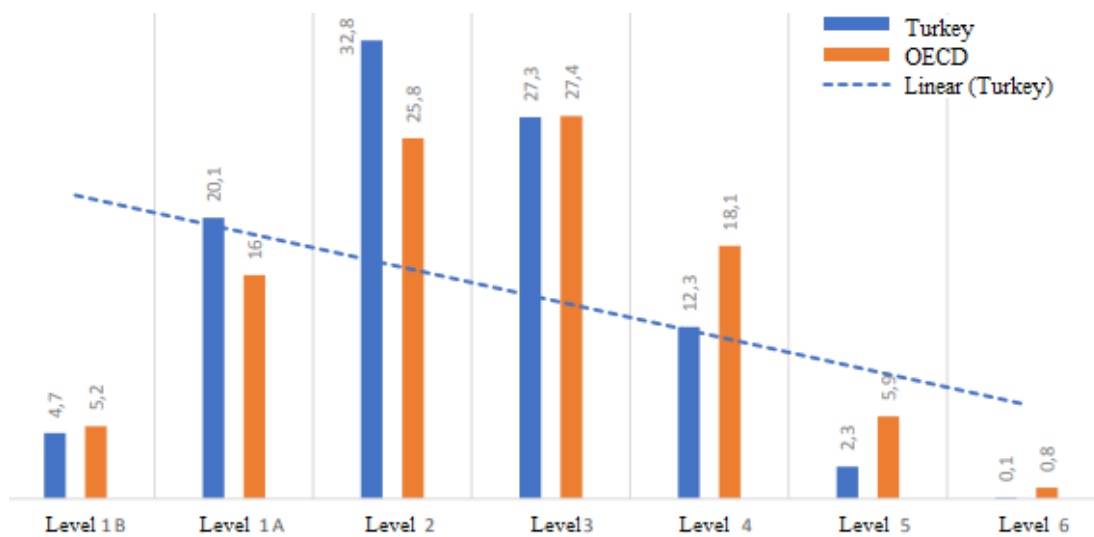*Adapted from OECD (2019b) Turkey data.

Figure 2. Ratios of 2018 PISA Research Science Scores by Proficiency Levels (%)

Each level stated in Figure 2 aims to determine what the scores of the students mean and to interpret them meaningfully. Each proficiency level defines the types of knowledge and skills required to successfully complete the tasks it contains. The closer you get to Level 6, the harder the skills required to successfully complete each level. Each proficiency level corresponds to a range of 80 points. Therefore, a difference of 80 points can be interpreted as the difference between consecutive proficiency levels. In the PISA 2019 report, it is stated that there is an average of 40 points difference between each grade level between countries. OECD emphasizes that this point value can be expressed as "learning in one school year" in making a meaningful and practical contribution to interpretation, but it is necessary to consider the limitations created by the many variables that affect the performance of countries (OECD, 2019b). In this direction, seven proficiency levels in

the context of science literacy and the characteristic features of the levels are presented in Table 1.

Table1. Summary Description of the Seven Levels of Science Proficiency in PISA 2018

Level	Characteristics of tasks
6	At Level 6, students able to draw on a range of interrelated scientific ideas and concepts from the physical, life, earth and space sciences and use content, procedural and epistemic knowledge to offer explanatory hypotheses of novel scientific phenomena, events, and processes or to make predictions. In interpreting data and evidence, they can discriminate between relevant and irrelevant information and can draw on knowledge external to the normal school curriculum. They able to distinguish between arguments that are based on scientific evidence and theory and those based on other considerations. Level 6 students able to evaluate competing designs of complex experiments, field studies or simulations and justify their choices.
5	At Level 5, students able to use abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, events and processes involving multiple causal links. They can apply more sophisticated epistemic knowledge to evaluate alternative experimental designs, justify their choices and use theoretical knowledge to interpret information or make predictions. Level 5 students able to evaluate ways of exploring a given question scientifically and identify limitations in interpretations of data sets, including sources and the effects of uncertainty in scientific data.
4	At Level 4, students able to use more complex or more abstract content knowledge, which is either provided or recalled, to construct explanations of more complex or less familiar events and processes. They can conduct experiments involving two or more independent variables in a constrained context. They can justify an experimental design by drawing on elements of procedural and epistemic knowledge. Level 4 students can interpret data drawn from a moderately complex data set or less familiar context, draw appropriate conclusions that go beyond the data and provide justifications for their choices.
3	At Level 3, students able to draw upon moderately complex content knowledge to identify or construct explanations of familiar phenomena. In less familiar or more complex situations, they can construct explanations with relevant cueing or support. They can draw on elements of procedural or epistemic knowledge to carry out a simple experiment in a constrained context. Level 3 students can distinguish between scientific and non-scientific issues and identify the evidence supporting a scientific claim.

2	At Level 2, students able to draw on everyday content knowledge and basic procedural knowledge to identify an appropriate scientific explanation, interpret data and identify the question being addressed in a simple experimental design. They can use basic or everyday scientific knowledge to identify a valid conclusion from a simple data set. Level 2 students demonstrate basic epistemic knowledge by being able to identify questions that can be investigated scientifically.
1a	At Level 1a, students able to use basic or everyday content and procedural knowledge to recognize or identify explanations of simple scientific phenomena. With support, they can undertake structured scientific enquiries with no more than two variables. They can identify simple causal or correlational relationships and interpret graphical and visual data that require a low level of cognitive demand. Level 1a students can select the best scientific explanation for given data in familiar personal, local and global contexts.
1b	At Level 1b, students able to use basic or everyday scientific knowledge to recognize aspects of familiar or simple phenomena. They can identify simple patterns in data, recognize basic scientific terms and follow explicit instructions to carry out a scientific procedure.

*(OECD, 2019b, p.113)

According to OECD, when we look at the levels of proficiency in science literacy, Level 2 is the basic proficiency level and represents the level of achievement in PISA. Level 2 can be regarded as the science proficiency level at which students demonstrate competencies that will enable them to interact effectively and efficiently with science and technology-related subjects. "Level 2, however, does not define an adequate level of science literacy and sets a key threshold at which students typically need some support to engage with science-related questions, even in familiar contexts" (OECD, 2019b, p.114). From this point of view, considering that the PISA results are evaluated within the framework of science literacy, it is necessary to discuss our position according to the proficiency levels in PISA rather than how many points have been increased compared to 2015.

High-level competencies in the context of science literacy, on the other hand, indicate the ability of students to use their science knowledge creatively and autonomously by employing scientific process skills in a wide variety of contexts (what they know or do not know). OECD defines students who perform below PISA level 2 as "low achievers". The rate of students performing below level 2 in Turkey is 25.1%. The rate of students with a high level of performance (Level 5-6) is 2.4%. This ratio can be described as a small ratio when compared to the countries that are in the top rankings in PISA. However, it is noteworthy that there is an increasing trend compared to previous years.

When Figure 2 is examined, it is important to note that there has been a significant decrease in the performance rates of Turkish students, especially from Level 4, compared to the OECD average. From this point of view, it can be said that students in Turkey did not have sufficient success in science literacy in the below proficiencies:

• Using more complex context information to structure descriptions of less familiar events or processes.

• Designing experiments involving two or more independent variables in a limited context and proving an experimental design.

• Interpreting the data obtained from a data set, obtaining appropriate results based on justifications.

• Ability to use abstract scientific ideas or concepts to explain unknown and complex events, situations, and processes.

• Applying epistemic knowledge to evaluate alternative experimental designs, make predictions, verify their decisions, and interpret information.

• Being able to evaluate ways to explore a problem scientifically and identify limitations in interpreting datasets, including uncertain influences and sources in scientific data.

• Ability to use epistemic knowledge to present hypotheses of scientific phenomena, events and processes that require multiple steps or require predictions,

• To distinguish between relevant and irrelevant information and to use information outside the school curriculum when interpreting data and evidence.

• To distinguish between arguments based on scientific evidence and theory and arguments based on other considerations,

• To evaluate complex experiments, field studies or simulations and justify their selection.

The rate of students who do not have the skills listed above is 85.3%.

These findings are compatible with the national data of Turkey. The Evaluation and Examination of Academic Skills (ABIDE), conducted by MoNE (2019a, 2019b) and sampled from 4th and 8th grade students in Turkey, is a comprehensive national research. When the ABIDE 4th grade level is examined, it can be seen that the rate of students performing at the Advanced proficiency level is as low as 3.2%. When the scope of the questions at the advanced proficiency level is examined (MoNE,

2019a, p. 100), it can be said that the proficiency of the 4th grade students in Turkey is low in establishing relationships between scientific concepts, analyzing alternative explanations or predictions, designing controlled experiments that can explain science-related phenomena and events as well as explaining the reason, using science knowledge and skills to produce solutions to the problems they encounter, collecting data about the problems they encounter in daily life - presenting appropriate suggestions to solve the problem, adapting the scientific concept to other situations in daily life. In the 8th grade level of the same research, it is seen that the rate of students with advanced proficiency (the level that points to higher-order thinking processes in science) is 2.5%, which is significantly low. It is also noteworthy that the rate of students reaching advanced proficiency level has decreased when compared to 2016 (MoNE, 2019b, pp.111-112). This national finding is also in line with the PISA 2018 findings.

Although the sample of the PISA research comprises of 15-year-old students, approaching the subject only from the perspective of secondary education will lead to misconceptions in interpreting the findings obtained from the research of science education in Turkey. As a matter of fact, the acquisition of competencies in the context of science literacy are based on primary education and even pre-school period. At this point, it is necessary to interpret the trend that Turkey has revealed in science over the years with the PISA research, according to the MoNE Science Curriculum (2018) and the practices in this direction. The 2013 Science Curriculum in Turkey was based on the research-inquiry approach. With the curriculum revised in 2017, an understanding of developing field-specific skills is observed in terms of scientific process, life and engineering-design skills. From this point of view, that Turkish students could not reach the desired proficiency in PISA science literacy skills may be because the basic dynamics of the curriculum could not be reflected in the application processes in the field. This finding also points out that there is a need to reconsider all aspects of curriculum implementation.

When the PISA research findings are analyzed in terms of the gender factor, among OECD countries, girls performed slightly better than boys with 2 points in science, while in Turkey girls outperformed boys with 7 points in science. Among high-performing students in mathematics or science, one in three children in Turkey expects to work as an engineer or in a science-related profession, compared to about one in five girls. This finding shows that female students with high science achievement are less interested in choosing professions in engineering or science-related fields. However, the findings also reveal that approximately one in two high-performing girls expects to work in health professions, and approximately one in four high-performing boys wants to choose health-related occupations. 2% of boys and a negligible percentage of girls in Turkey expect to work in ICT-related occupations (OECD, 2019a). Institutions operating in educational sciences argue that specialization in STEM professions and interest in these professions

should begin in secondary school (Kier et al., 2013). Research in this field reveals the importance of the 10-14 age range in shaping the career choices of children regarding STEM in the following years (Dejarnette, 2012, DeBacker & Nelson, 1999;Murphy & Beggs 2005). When primary school science education policies in Turkey are examined, it is important to note that STEM applications and field-specific skills were included in the curriculum updated in 2018. When the national studies examining the interest in STEM professions in the secondary school period are examined, it is observed that male students show more interest in STEM professions (Koyunlu-Ünlü & Dokme, 2018; Uğras, 2019).

In this context, socio-economic status is expressed by the OECD as a powerful indicator of performance in mathematics and science in all countries taking part in PISA (OECD, 2019d). So much so that 11% of the change in science performance in Turkey in PISA 2018 (with the OECD average of 13%) is explained by the socio-economic status difference (OECD, 2019c). This finding points to the school ecosystem that will minimize the disadvantages of students arising from their socio-economic status. The relationship between success differences between schools and socioeconomic characteristics and student achievement has been taking place in education debates in Turkey for many years. In the studies on the subject, it is seen that the relationship between socioeconomic characteristics and academic achievement is moderately intensified, and the socioeconomic factor is stronger than other variables whose relations with academic achievement are examined (Suna & Özer, 2021). Regarding this issue, OECD Secretary General Angel Gurria stated that; " While students from well-off families will often find a path to success in life, those from disadvantaged families have only one single chance in life, and that is a great teacher and a good school. If they miss that boat, subsequent education opportunities will tend to reinforce, rather than mitigate, initial differences in learning outcomes" (OECD, 2019d, p.4).

Geographical region differences are another powerful factor affecting success in PISA. According to geographical regions in Turkey, the highest average score in science in PISA 2018 is in Western Anatolia with 489 points, which is equivalent to the OECD science average. The lowest average score is in Middle East Anatolia with 423.5 points (OECD, 2019c). These findings show that the score difference (65.5) arising from the differences between geographical regions in science in Turkey is significantly high (considering that a difference of 40 points corresponds to one year of learning).

Implications and Recommendations for Turkey in the Context of PISA

Based on all these, some suggestions are given below for policy makers, educators, teachers, and school administrators in Science Education. In a general framework, PISA 2018 ranked the top 10 in science, China, Singapore, Macau, Estonia, Japan, Finland,

South Korea, Canada, Hong Kong, and Taiwan. It is thought that examining the basic dynamics of these countries in raising science literate individuals and making inferences in our Science Education will strengthen the current policies. As a matter of fact, the PISA research reveals findings toward providing feedback by drawing attention to the aspects of education and training practices that need improvement. Science, Physics, Chemistry and Biology Curriculums in Turkey are being renewed and developed within the framework of today's science education approach. However, PISA findings show that very few of the students can show high-level competencies in science. When the studies that attach importance to 21st century skills for the future of societies are examined, it is seen that there is a great emphasis on cognitive skills, which we can call high-level thinking skills, as well as social skills that include global communication and cooperation (EURYDICE, 2020; NcREL, 2003; OECD, 2018; World Economic Forum [WEF], 2020). However, PISA findings show that very few of the students can show a high level of performance in science. From this point of view, science education in Turkey should be reconsidered based on the questions given below.

- How many does it serve a process (curriculum, teacher, and school dimensions) where the student can transform the knowledge they have into a skill in real life?

- Can they make science knowledge a necessity?

- Does it provide a need to know and learn?

- Functional, versatile, and flexible in developing scientific process skills, higher-order thinking skills, engineering, and design skills?

- Can he/she handle regional differences flexibly at the level of contexts (real-life situations and problems)?

- Is it far from a conceptual understanding isolated from the real lives of students?

- Does it have a structure that includes every student in the scientific research process, experiment and observation, and technical-technological environments inside and outside the school?

PISA research focuses on what students can do with their knowledge and to measure their skills in the most appropriate way in science. The Science course can be described as a real-life workshop, based on experimentation and observation, in which research-inquiry, scientific thinking and design skills are employed. So much so that students are always intertwined with scientific concepts in their daily lives. We can talk about in-depth learning and high-level skills if the student can use the scientific knowledge, he has gained here to solve or understand a problem-situation he/she encounters in real life, transfer it to other situations and produce creative solutions. The measurement and

evaluation dimension of such a learning process should have a function that appeals to the individual differences of the student, reveals the high-level competencies, and can reveal the individual performance beyond the classical methods at all levels, from the evaluation made by the teacher in the classroom to the national exams.

PISA 2018 findings reveal that girls in Turkey are seven points ahead of boys in science scores. However, it is a striking finding that female students are less willing to choose engineering and science-related professions than male students. At this point, it is thought that it will be beneficial to carry out applications and projects that will positively increase the attitudes of girls towards the professions related to engineering and science. However, it would be beneficial to emphasize gender equality in all components of the learning ecosystem, especially in textbooks. As a matter of fact, many countries have developed policies and implemented projects (Educational Advancement campaign in Germany, Girls and technology initiative-Women in Engineering in Austria, Girls and Technology in Netherlands) based on the importance of STEM professions in social development (European Commission/EACEA/Eurydice, 2010).

According to the PISA research data, the disadvantage of students in Turkey depending on their socio-economic status is an important factor affecting science achievement. The only place where the student can minimize their disadvantage is the school and the only person who can eliminate this negative effect is the teacher. From the point of view of science education, science laboratories are an integral part of science lessons. In this sense, it is necessary to establish and develop science laboratories in every school, and to offer equal opportunities and learning opportunities to every student in a fair manner. It is important to increase teacher training and invest in teacher professional development within the framework of scientific research, new teaching approaches and practices in science education.

According to PISA 2018 findings, one of the primary factors affecting science achievement in Turkey is the disadvantages arising from geographical region differences. Although the sources of this disadvantage are various, it is necessary to investigate the factors that may cause the difference in success between geographical regions and to develop data-based solutions. In the context of science education, increasing the facilities such as science laboratories and design workshops in schools in disadvantaged regions, developing science and art schools in the region, and establishing science centers should be the primary goals. Encouraging and supporting teachers in making use of these centers with equal opportunities, participation in scientific activities and increasing projects will minimize the problems arising from the mentioned disadvantages.

TIMSS Scope of Evaluation

Another international indicator that we can make inferences for Turkey in the dimension

of Science Education is the Trends in International Mathematics and Science Study (TIMSS) conducted by the International Association for the Evaluation of Educational Achievement (IEA). Over 60 countries are actively involved in the IEA network, and over 100 education systems take part in IEA's studies. TIMSS 2019 marks the seventh cycle of the study and provides 24 years of trends. Conducted every four years since 1995, TIMSS has been a valuable tool for monitoring international trends in mathematics and science achievement at the fourth and eighth grades (https://www.iea.nl/studies/iea/timss/2019). According to the Ministry of National Education (MoNE, 2020) data, Turkey has been taking part in TIMSS research since 1999. 58 countries at the fourth-grade level and 39 countries at the eighth-grade level took part in the TIMSS 2019 application (TIMSS, 2020). Turkey took part in the TIMSS 2019 cycle, with 180 schools, 4,028 students at the fourth-grade level and with 181 schools, 4,077 students at the eighth-grade level (MoNE, 2020). When TIMSS (2020) Turkey science findings are considered, we see that first, 5th grade students from Turkey are included. It can be said that participation at the 5th grade level is appropriate in terms of its overlap with the international averages of age and the achievements in our curriculum.

TIMSS research uses three basic dynamics to evaluate science achievement. The first of these is content areas. TIMSS 2019 assessed three content areas in science at the fourth grade: life science, physical science, Earth science and eigth grade: Biology, Chemistry, Physics and Earth Science (TIMSS, 2020, p.235). Questions evaluating science achievement consist of questions covering these learning areas. Within the scope of the assessment, the second basic dynamic is "Cognitive Fields". TIMSS emphasizes that students should benefit from a range of cognitive skills while solving questions. Cognitive domains consist of Knowing, Applying, Reasoning cognitive process skills. Knowing covers scientific facts, concepts and procedures that the student should know. The application requires the student to transform the knowledge and concept into practice and the ability to develop a conceptual understanding. Reasoning includes higher-order thinking processes, such as research design, synthesis, analysis, making, and providing creative and critical solutions (TIMSS, 2020).

The third fundamental dynamic is International Benchmarks. TIMSS describes achievement at four points along the scale as International Benchmarks: Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400) (TIMSS, 2020, p.106). The TIMSS sub-proficiency level shows the lowest benchmark to be achieved, according to the United Nations Sustainable Development Goal (MoNE, 2020, p. 32). Based on this basic structure, evaluating Turkey's science achievement in terms of proficiency levels and content areas rather than ranking based on average will provide more enlightening information.

What Do TIMSS "Science" Findings Say for Turkey?

In the TIMSS(2020) fourth-grade level science assessment, Turkey ranks 19th among 58 taking part countries, with an average score of 526 (p.80). At the eighth-grade level, it was ranked 15th among 39 countries, with an average science score of 515 (p.213). These rankings are above the midpoint of the scale in the TIMSS cycle. Turkey has been taking part in TIMSS in both grade levels since 2011. Therefore, for a healthy and comparative interpretation, it would be more accurate to refer to the year 2011 at both grade levels. TIMSS findings are valuable because students who were in the 4th grade in 2015 are in the eighth grade in 2019, allowing a longitudinal assessment. In this context, it is seen that eighth graders have increased their scores by 22 points compared to 2015. In an education system like Turkey, where the student population is higher than the total population of many countries, achieving meaningful performance increases is undoubtedly an important achievement. That there is a continuous upward trend in the 2011, 2015 and 2019 TIMSS cycles and this increase is brought to the top in the 2019 cycle is a clear indicator of this performance increase (Suna & Özer, 2021, p. 12). However, as stated in the previous section, it would be more beneficial to examine the findings according to proficiency levels, cognitive domains, and content areas rather than country rankings. In this context, prominent findings in science achievement and evaluations in the context of Turkey are presented below, respectively;

• There is an increase in the number of students who can reach advanced proficiency level in both fourth and eighth grades compared to 2015. There is a decrease in the number of students who fall below the basic competencies level. However, a non-negligible rate (10% in 5s, 12% in 8%) is below the basic proficiency level.

• When analyzed according to Content Domain, the field with the highest achievement in both the fourth and eighth grades is physics. However, the field with the lowest achievement at both grade levels is earth sciences. When the MoNE Science Curriculum (2018) is examined, Earth Sciences makes up 13.9% of all achievements in the fourth grades, while there is no acquisition related to this content area in the eighth grades. This situation may cause Turkish students to perform at a lower level in Earth sciences than in other content areas.

• In the context of Cognitive Domain, it is observed that eighth graders increased their reasoning scores by 12 points and their Applying scores by 15 points compared to 2015. These score increases can be considered as the widespread effect of MoNE Science Curriculum (2018), which was revised in 2017 within the framework of research-inquiry approach. However, in the fourth grade, Reasoning scores are 6 points behind the TIMSS average, while Applying scores are 2 points above the average. In addition, it is noteworthy that fourth-year students have a

lower level of success in "Reasoning" cognitive than applying. This emphasizes the need to focus on higher-order thinking skills during the primary school period.

• In the context of gender; While boys are ahead of girls in the fourth grades in terms of points, it is observed that there is a difference in favor of girls in the eighth grades.

• When examined in terms of access to Home Educational Resources (number of books in their homes, other study supports, number of children's books, the educational status of the parents and the professions of the parents) are examined, there is a dramatic difference between the advantaged and the disadvantaged student groups (153 point in the fourth grade and 145 points in eighth grade). The TIMSS success average of Turkish children, who are advantaged in terms of home resources, is higher than Singapore's points. At this point, one of the main variables affecting science achievement in Turkey is socio-economic differences among students. For this reason, it comes to the fore that it is necessary to seriously support disadvantaged student groups in Turkey.

• When examined in the context of Students Attended Preprimary Education, the science success of Turkish students increases as the primary education year increases. The science achievement of students who cannot reach pre-school education is 74 points less than students who are advantaged in this regard. This finding reveals that pre-school education has a direct relationship with the success of the child in the following years.

• Socioeconomic Background of the Student Body: It is seen that there is an average of 55 points difference between the science achievement scores of children from families with high income and those from poor families in both the fourth and eighth grades (in favor of children from high-income families). It is noteworthy that 44% of the students participating from Turkey have a low-income level. For example, in Finland, this rate is around 10%. Based on this finding, the economic opportunities of families in Turkey have an active role in science achievement.

• The Instruction Affected by Science Resource Shortages includes principals' reports about two kinds of resource shortages affecting instruction: general school resources (Instructional materials, Supplies, School buildings and grounds, Heating/cooling and lighting systems, Instructional space, Technologically competent staff, Audio -visual resources for delivery of instruction, Computer technology for teaching and learning) and resources specific to science instruction (Teachers with a specialization in science, Computer software/applications for science instruction, Library resources relevant to science instruction, Calculators for science instruction, Science equipment and materials for experiments) (TIMSS, 2020, pp. 329-330).

In Turkey, the science achievement scores of students in schools with insufficient scientific resources are quite low compared to schools rich in these resources (49 points in the fourth grades, 57 points in the eighth grades). This finding shows that the school's being equipped with scientific resources is a factor that directly affects science achievement.

• It is seen that fourth-grade students with a high level of Students' Sense of School Belonging have a 27-point difference in success compared to students with a low sense of belonging to school. However, the variable of feeling belonging to school in eighth grades did not make any difference in science achievement.

• Students' science achievement scores increase if teachers include the scientific research process in their lessons. When the number of experiments in the lesson's scope is compared between the fifth and eighth grades, it is observed that the frequency of experimentation in science lessons in the eighth grades decreases. The reason for this may be the anxiety of science teachers to be able to train their curriculum and their preparation for the high school entrance exam.

• Access to technology within the scope of science lessons is 20% in the fourth grade and 15% in the eighth grade. These rates are well below the TIMSS average.

• While the rate of liking the science, lesson is 69% in the fourth grade, this rate is 52% in the eighth grade. However, the value given to science is well above the TIMSS average in eighth grades (46%). It is observed that this rate is quite low in countries such as South Korea, Japan, and China, which are at the top of TIMSS science achievement. In the scope of the value given to science, the high mean score in the eighth grades may be related to the fact that science scores are effective in getting a good high school in our country.

•In terms of self-confidence rates in science lessons, a rate of 58% in the fourth grade and 38% in the eighth grade draws attention.

•When the experience of teachers in terms of professional years is examined, it is seen that there is an increase in the success of the students as the years of professional experience increase. Especially the students of science teachers with 20 years or more experience got the highest scores. It is noteworthy that the average science score of the students of teachers who have five years or less experience is low. This finding draws attention to the necessity of increasing studies on the training and development of teachers.

•The most successful region in terms of science achievement is East Marmara in both the fifth and eighth grades. The most unsuccessful region is the Southeast

Anatolia Region in both grades. However, the Southeast Anatolia Region is one region that increased the Science Achievement score the most compared with 2015. Compared to 2015, there is a 14-point decline in the Western Black Sea Region in terms of science achievement scores in eighth grades. The necessity of evaluating the reasons for this situation specific to the region comes to the fore.

•When examined in terms of the frequency of feeling tired and hungry; The rate of students who feel hungry every day in the fourth grade is 40%, and 46% in the eighth grade. How efficient can the educational process be in terms of improving student success in an environment where basic needs are not met?

Implications and Recommendations for Turkey in the Context of TIMSS 2019

Based on all these, some suggestions are given below for policy makers, educators, teachers, and school administrators in the context of Science Education. In a general framework. In a general framework, TIMSS 2019 data shows that Turkey has made significant progress in science achievement compared to the previous cycle. Besides this positive development, the rate of children who are below the basic proficiency level is still at a level that we cannot ignore. This finding points to a science education approach focused on developing high-level competencies. When we consider it from the perspective of Turkey, it is stated in the MoNE (2018) Science Curriculum that the role of teachers is to guide students to integrate science, technology, engineering, and mathematics and to bring students to the level of high-level thinking, product development, invention, and innovation. In other words, the emphasis that the effective factor in gaining these skills is the teacher draws attention. However, it is also important to design a science education system that will empower the teacher in increasing high-level skills and competencies. The necessity of empowering teachers with curriculum, textbooks, applications that provide science-technology integration, school resources (laboratory, technological integration, materials, etc.), out-of-school resources and qualified training in the profession is revealed by the findings of TIMSS 2019 and PISA 2018.

In interpreting the TIMSS findings, it is possible to consider the differences in science achievement in two dimensions: student (home-family characteristics) and school-related differences. According to TIMSS-2019 data, one of the main variables that causes student-based achievement differences in Turkey is socioeconomic differences among students. According to the TIMSS (2020) findings, the rates of socioeconomic differences in affecting science achievement are very close to each other in both fourth and eighth grades. This finding shows us that children from low-income families at both primary and secondary school levels should be supported academically and socially. Another important finding that provides a basis for supporting socioeconomically disadvantaged children is pre-school education. As a matter of fact, according to the

TIMSS findings, there is a direct positive relationship between the duration of the child's pre-school education and his success in the following years. According to the research of Magnuson et al. (2004) in most instances, the effects are largest for disadvantaged groups, raising the possibility that policies promoting preschool enrollment of children from disadvantaged families might help to narrow the school readiness gap. Preschool education reduces social inequalities in educational achievement (Cebolla-Boado et al., 2017). Supporting children with pre-school education is an important force that can tolerate socioeconomic disadvantages. For this reason, pre-school education in Turkey should be made compulsory, albeit late.

Another student-based success factor is the home-related dimension. In Turkey, there is a dramatic difference between the science achievements of children with advantaged about Home Educational Resources (number of books in their homes, other study supports, number of children's books, the educational status of the parents and the professions of the parents) and those with scarce resources. When the ABIDE 2018 data is analyzed, similar results are reached, but another striking finding is that 49.8% of the students in Turkey do not have their own tablet or computer, and 54.5% do not have an internet connection (MoNE, 2019a). At this point, it should be aimed to reduce inequality in education and measures should be taken at the level of country policies in favor of disadvantaged students in terms of household resources. In Turkey, the education program in primary school (IYEP-third grades) and Support and Training Courses (DYK) in secondary school period and programs to provide students with the opportunity to make up for their deficiencies are carried out by MoNE (MoNE, 2019; MoNE, 2021). However, there is a need for official assessment and evaluation findings and feedback on the scope, competencies, and effects of these programs. Considering the secondary school period, the technical infrastructure of the schools for science lessons is an important dimension. Because of the nature of the science lesson, it is a field that requires being involved in research-inquiry-problem solving and learning through experimentation, and access to laboratory equipment, scientific and technological resources is necessary. For this reason, the equipment of schools is important in closing the inequality between students. As a matter of fact, according to the findings of TIMSS (2020), the science achievement scores of the students in schools with insufficient scientific resources in Turkey are quite low compared to the students at schools rich in these resources (49 points in the fourth grades, 57 points in the eighth grades). This finding shows that the school's being equipped with scientific resources is a factor that directly affects science achievement.

On the other hand, in Turkey, students' science achievement scores increase to the extent that teachers include the scientific research process in their lessons. It is observed that the frequency of experimentation in science lessons in eighth grades is much less than in fifth grades (TIMSS, 2020). In the context of Turkey, there may be different

reasons why less experiments are done in lessons as the grade level increases. The first of these is that compared to the MoNE (2018) science curriculum, the number of achievements is higher in 8th grades. Teachers may be giving less time to scientific research and experiments to complete the achievements and to prepare for the 8th grade high school entrance exams in Turkey. In addition, researches have shown that teachers' competencies in the implementation and conduct of science experiments (Demir et al., 2011; Nakiboğlu & Sarıkaya, 2000; Ültay et al., 2020), their beliefs and thoughts about science (Kılıç et al., 2015) also shows that it can be effective. In addition, the science laboratories of the schools do not have sufficient technical equipment (Akıncı et al., 2015; Soğukpınar & Gündoğdu 2020; Şimşek et al., 2012), the number of students in the classrooms is high (Akıncı et al., 2015; Ayvacı & Durmuş, 2013) are the findings in the literature in such cases. It can be said that the competence and self-confidence of science teachers in Turkey has increased compared to previous years. This situation can be seen in proportion to the increase in the number of more applied training and laboratory courses in the teacher training process. At the same time, it can be considered as a reflection of the responsibility imposed on teachers by the changing curriculum (Celik et al., 2021). The most important feature that distinguishes science education from other branches of science; It gives importance to experiment, observation, and discovery, develops students' questioning and research skills, and provides students with the opportunity to form hypotheses and interpret the results (Yazıcı & Özmen, 2015). For this reason, in the light of TIMSS findings, it is necessary to take necessary measures in terms of school, teacher and curriculum to conduct secondary school science lessons based on experiment, observation and practice. According to TIMSS (2020) findings, it is observed that students of science teachers with 20 years or more experience reach the highest scores. It is noteworthy that the average score of the students of teachers who have five years or less experience is low. This finding brings to the fore the increase of studies on the training and development of teachers. Another dimension that TIMSS findings point to in science achievement differences is the geographical region factor. This finding brings up the inequalities in access to education and the quality of education according to geographical regions in Turkey. Kıbrıslıoglu-Uysal and Gelbal (2019) evaluating equality of opportunity in education longitudinally within the framework of PISA findings and TUIK data, they stated that the distribution of limited resources and quality allocated to education in Turkey is not balanced within the country. Based on the TIMSS 2019 findings, the average score of Turkish students, who are advantageous in terms of socioeconomic, home and school resources, approaches the ceiling score in TIMSS ranking. However, children who have scarce resources at home and school, and who are socio-economically disadvantaged, slip into the bottom line in science achievement. Reducing inequalities in education will minimize the risk factors for students to take active roles in society. It is inevitable for all students to be successful when children have a more equal and fair system in access to education and distribution of resources.

Final Say

The COVID-19 pandemic, which our world is facing at the beginning of 2020, reminded the necessity and importance of the ability to create virtual work environments by combining technology and virtual environments in education. The Covid-19 pandemic has opened the door to a new education paradigm where education is continued with "distance education". In addition, inequalities in access to education have deepened with the pandemic. The coronavirus crisis has revealed deep inequalities not just in the digital divide but also who has the skills to self-direct their learning, and whose parents have the time to help (Soler & Dadlani, 2020). According to TIMSS (2020) and OECD (2019b, 2019c, 2019d) PISA reports, access to education and equal distribution of resources are the primary factors affecting success in science education in Turkey. The fact that inequalities in education cause serious learning differences will lead to more dire consequences with the prolongation of the closure of schools in Turkey in covid-19. In this process, accessible and inclusive learning is gradually increasing the responsibilities of all education systems. As education continues to be a key driver of social mobility and well-being, learning systems must shift toward more accessible, and therefore more inclusive, methods to ensure access to opportunity for everyone. Without such a transformation, current trends risk further exacerbating inequality (WEF, 2020). In this process, which carries a significant risk for disadvantaged children (in terms of socioeconomic, access to education, home, and school resources) in Turkey, identifying and compensating learning losses, supporting students socially and psychologically should be the most important agenda topic for the education policies of the country.

With this, since the Science Course is a course that mostly includes experiments, observations, laboratory applications and real-life contexts, teachers in Turkey face some difficulties in teaching this course via distance education and in this way gaining field-specific skills (Bakioğlu & Çevik, 2020; Pınar & Dönel- Akgül, 2020). According to UNESCO, "science teaching is a strategic imperative for a country to meet the basic needs of its people." (WEF, 2020). Science education, by its nature, is a field that requires being involved in research-inquiry-problem solving and learning through experimentation, and access to laboratory equipment, scientific and technological resources is necessary. For this reason, starting from preschool with a more democratic approach in science education, it is important to create school/out-of-school systems where every child can access scientific resources, to encourage students to learn science, to develop their creativity, innovation, and reasoning skills, and to inspire them to use what they have learned on a social level. Researches such as TIMSS and PISA have a key role in identifying our deficiencies and strengthening the system. Monitoring current trends in the education systems of nations can enable teachers, school administrators, parents, and policy makers to draw conclusions and make more effective decisions in revising education.

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About Author

Sema Aydin-Ceran, PhD, is Assistant Professor of Division of Classroom Education at Selcuk University in Konya, Turkey. She holds a PhD in Elementary Science Education from Gazi University of Turkey. Her main area of interest are Real-Life Context Based Learning, different measurement techniques, individual differences, scientific creativity, scientific process skills and conceptual learning in science education. Also, she has interest about studies on primary school science education and carries out projects on parents' education in developing children's scientific research skills.e-mail: sema.aydinceran@selcuk.edu.tr, ORCID iD, https://orcid.org/0000-0001-6847-2766

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The Concept of Sustainable Development in Turkish Science Education

Hayriye Nevin Genc
Necmettin Erbakan University

Introduction

The rise in the human population, wealth, advances in science and technology, and the impact of man on the environment are issues that today's people have to face. The resources of our world also have a limit. We know that we are very close to that limit due to human activities. As a result of the destruction of indifferent and ruthless steps taken in the name of industrialization and development, the self-renewal ability of the world is decreasing. For this reason, people are faced with many problems such as global warming, climate change, endangered creatures and an unsuitable environment for life. Industrialization has brought important benefits and upgraded technologies for the economic welfare of the society, but on the other hand, since the environment is used as a resource in the industrialization process, it has not a positive effect on environmental sustainability, but has negative effects.

The natural systems of the world show many symptoms such as the destruction of the ozone layer due to increasing human population, increased consumption and waste, climate change, nitrogenization of the biosphere, extinction of many species, new types of pollution and the difficulty of accessing drinking water. This situation affects living and non-living things and the relationship between them (Atmaca, 2018).

In general terms, sustainability can be expressed as the capacity for continuity of a situation or phenomenon. Therefore, the concept of sustainability is a concept that expresses a process because the ecosystem expressed by the concept is to ensure that people benefit from many phenomena such as atmosphere, water and land resources for generations (Eryılmaz, 2011).

Development, on the other hand, is the attempts made to become better than the current situation of individuals or societies. It is a wide-ranging concept that covers all the efforts made for the positive development of the economic, social and cultural structure of societies (Tolunay & Akyol, 2006; Atmaca et al., 2018). Sustainable Development (SD) is a concept that is formed by the terms "Sustainability" and "Development" and includes more than one discipline area (Çelik, 2019).

Sustainable development is a concept whose definition is controversial because it has a wide variety of meanings. Since sustainable development is adopted by many audiences such as governments, large businesses and environmentalists, field-based definitions are made for each audience (Giddings et al., 2002)

The most general definition of sustainable development in the literature is the definition in the Brundtland Report (Our Common Future) prepared by the United Nations Commission on Environment and Development in 1987 as "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

If it is desired for individuals to make sustainable development principles a lifestyle, the way to do this is to educate individuals according to the goals and principles of development. For sustainable development, education is an issue that should be promoted on a global scale, just like sustainable development. To emphasize the importance of education for sustainable development, the period between 2004 and 2015 was declared as the 'Decade of Education for Sustainable Development' by the United Nations. With the declaration of the Decade of Education for Sustainable Development, it is aimed to provide an opportunity for all individuals to learn about the results, behaviors and lifestyles of improvements made in the fields of society, economy and environment for sustainability (Çolak, 2012).

It is certain that individuals who grow up with an appropriate, effective and productive science education will be one of the most beneficial individuals in the development oftheir country and in all areas. Science course is one of the courses in which students will gain awareness of sustainable development.For this reason, it is very important that the students of the science education department, who will be the science teachers of the future, graduate as teacher candidates with sustainable development awareness. Sustainable development awareness of students depends on science teacher's knowledge about sustainable development (Çobanoğlu & Türer, 2015). For all these reasons, science education is an indispensable educational field for sustainable development.

Sustainable Development and Education

Society consists of people who live in a certain environment, serve a common purpose, and cooperate by adhering to certain rules. Education, on the other hand, is the process of creating a desired change in the behavior of the individual through his own life and intentionally. It is all the processes that the individual changes and develops the knowledge, attitudes, abilities and other behavior patterns that are valuable for the society he lives in. In short, education can also be defined as the process of developing behavior in the desired direction. Every society needs education and training institutions to develop and progress. Education is the set of rules created by society. Therefore, society and education are closely related concepts (Aslan, 2001).

It is possible to make the desired changes in the behavior of the individuals who make up the society through education. Education of individuals is essential for the realization of sustainable development. Individuals who are conscious of sustainable development are those with high responsibility towards their environment and they shape their lives by considering the needs of the next generations (Kanmaz, 2019).

Human and environmental relations are at the center of education approaches for environmental education and sustainable development. However, while environmental education focuses on environmental problems and how to solve them so that we can have a better future, education for sustainable development focuses on the conditions in which people live and social development for a desired future (Pavlova, 2011). In education for sustainable development, unlike environmental education, human is at the center and it is aimed to transform sustainability into a lifestyle in the fields of economy, ecology and society. Environmental education has been given importance with the numerous conferences and international events since the 1970s, but in the late 1980s and early 1990s, with the introduction of a new vision to education, education for sustainable development entered our agenda (Palmer & Neal, 1994).

The key point in achieving the goal of sustainable development is individuals. Individuals are at the center of the economy, environment and society. The element that will realize sustainable development is individuals. It is very important for individuals in society to live in accordance with the goals and principles of sustainable development. This is only possible with education especially science education. In this context, the concept of education for sustainable development has come to the fore (Atmaca, 2018).

The great South African thinker Nelson Mandela says ''Education is the most powerful weapon which you can use to change the world'' and states how important education is for change, which is one of the most important goals of sustainable development. In today's world, the necessity of mentality change is undeniable in order to ensure sustainability. Education is an indispensable prerequisite for sustainable development as it enables individuals, communities, social groups, countries and institutions to make better and more accurate assessments and choices about sustainable development (Gürbüz, 2020).

In the ''Educational Strategy Vision for Sustainable Development'' report by United Nations Economic Commission for Europe (UNECE), education for sustainable development is defined as follows: Education for sustainable development develops and strengthens the capacity of individuals, groups, communities, institutions and countries to make assessments and choices in favor of sustainable development (Akgül, 2020). By changing the perspective of individuals, it makes our world safer, healthier and prosperous and improves people's quality of life. Education for sustainable development can provide opportunities for critical thinking, greater awareness and greater empowerment, which

are necessary for the discovery of new visions and concepts and the development of new methods and tools (Türer, 2010).

Education is at the center of sustainable development. But what is meant is not educational information overload. Education for sustainable development aims to educate individuals according to the principles of sustainable development in many aspects such as knowledge, attitudes, values and behaviors, with a program that includes environmental, economic and social issues.

Currently, at the point where the changing and increasing environmental problems arise, educators are given responsibilities for raising people who have adopted a sustainable lifestyle. In this case, it is inevitable that the subject of education for sustainable development will start to take place in the discussions about education strategies (Tuncer & Erdoğan, 2006).

According to UNESCO, Education for Sustainable Development can be achieved by developing skills, attitudes, values and understanding rather than passively receiving information. ''In some European Union country programs (Belgium, Finland, Greece, etc.), environmental education is given as a separate course, in others it is given with an interdisciplinary approach (Austria; Denmark, etc.) or intertwined with different courses (Netherlands, England, etc.)'' (Erikan, 2020).

''Sustainable development education will contribute to the development of a new understanding and sense of responsibility in the environmental, social and economic sense in students, as well as raising the awareness that the choices they make as a member of the society affect the whole society'' (Alkış & Öztürk, 2007). ''Sustainable development education does not only explain environmental issues with biological and physical parameters, but also evaluates economic, historical, cultural, aesthetic, social, political components and the interactions of these components within and among themselves'' (Okur, 2015).

In the 36th part of Agenda 21, which is the first document in which the definition of sustainable development education is made, the things to be done when starting sustainable development education are gathered under four main headings. These are described as,

- Improving basic education,

- Updating existing education in line with the requirements of sustainable development thought,

- Developing public awareness,

- Extending education and work to all public sectors.

Through sustainable development education, individuals have the capacity to gain and evaluate sustainable development awareness.

To achieve this goal, by calling for the following issues for governments, international agencies, businesses and non-governmental organizations in Agenda 21, it was emphasized that sustainable development education is an issue that should be addressed at the global level;

- Ensuring that everyone has access to basic education and functional literacy,

- Ensuring that environmental and development education is accessible to individuals of all age groups,

- Ensuring that the concepts of environment and development are integrated into all education programs with analyzes of the causes of major problems, including all individuals,

- Ensuring the inclusion of children in educational institutions in regional and local studies on environmental health, including clean drinking water, sanitation, environmental and economic impacts of food and resourse use (UNESCO, 2002; UNESCO, 2005).

Sustainable development education not only provides the present and future generations to be a fair society with environmental integrity, economic continuity and cultural diversity, but also provides the attitudes, behaviors and values necessary for an equal right to education, good social transformation and a sustainable future. It contributes to justice, gender equality, poverty reduction, democracy and peaceful societies (UNESCO, 2013).

After the World Sustainable Development Summit (2002), UNESCO was designated as the executor of Sustainable Development Education. Thus, UNESCO prepared a work program to accelerate the reforms on this issue and to coordinate the works of the relevant units. The main objectives in this program are:

- Identifying the key messages of education for sustainable development,

- Including the subject of education in the National Strategy and Action Plans,

- Ensuring that education policies are reviewed at the national level and that formal education systems are harmonized,

- Increasing investment in education,

- Providing trainings on the development of sustainable consumption and production habits in all countries,

- Developing awareness at the community level,

- Encouraging and sharing creative practices (Gürbüz, 2020).

One of the aims of sustainable development is to ensure that all individuals have equal rights and freedoms. In this context, with sustainable development education, the necessary environment is created for those with learning difficulties or socially disadvantaged individuals to receive education like healthy people (UNESCO, 2009).

To deal with sustainability in an education curriculum, the following five dimensions should be taken into account (McKeown, 2002):

Information: This is related to environment, social knowledge and economy. Students need to know what is going on around them, the activities of human beings and whether these activities have negative effects on the environment and what can be done to prevent these negative effects. However, students also need to know the dimensions of the relationship between the environment, society and economy. They should be aware of the basic concepts required for living together such as poverty, democracy, justice, peace and tolerance and they should lead their lives accordingly.

Problems: These are related to economic, social and environmental issues such as clean water, poverty, access to basic nutrients, decision making, protecting and managing the environment, which are the foundations of Sustainable Development Education. These topics/issues should be integrated into the education curriculum and should also be appropriate to the regional/local structure.

Skills: It is related to the skills that will enable individuals to interact with the environment correctly and meet the needs of the society they live in. However, skills should help individuals continue to learn so that they can continue their sustainable lives after leaving school. These skills can be listed as follows:

- The ability to communicate effectively (both orally and in writing),

- Thinking about systems (both natural and social sciences),

- Considering priority issues over time and anticipating outcomes

- Think critically about issues of value,

- Separating number, quantity, quality and value,

- Move from knowledge to action,

- Working collaboratively with other people,

- Using these processes: knowing, questioning, acting, judging, imagining, connecting, valuing and choosing,

- Develop an aesthetic response to the environment" (McKeown, 2002).

Perspectives: These are related to perspectives that individuals need to understand local issues as well as global issues in a universal sense. Students need to see problems from a global perspective. In addition, they should benefit from the views of different stakeholders while evaluating the issues. Here are some perspectives that students should grasp:

- Social, environmental and economic issues change over time.

- Today, global environmental problems are interrelated.

- Local issues must be understood in a global context, local and national boundaries of communities must be analyzed.

- A decision should be made on any issue, taking into account different points of view.

- Advancing technology and science cannot solve all our problems.

Values: These are about valuing people's personality, respecting the environment and other individuals in the world. Students need to grasp their own values, the values of the societies in which they live, and the values and sensitivities of other people and societies around the world. An important part of these values is social justice. Social justice includes meeting the basic needs of people such as shelter, nutrition and dressing, and respecting the values and traditions of different societies (Gürbüz, 2020).

As a result of sustainable development education, individuals should have the following competence areas (Kaya & Tomal, 2011):

- Reconciliation skills: This skill area considers sustainable development as a shared culture, includes the skills of negotiation and reconciliation with others.

- Skill to see and plan relationships: It sees the relationship between nature and culture and makes planning accordingly.

- Solidarity skills: It collaborates to achieve international equality for present and future generations.

- Motivational skills: It is willing for sustainable development and takes part in

studies to be done in this direction. It acts by considering future generations in all its behaviors.

- Critical thinking skills: It develops guiding principles for an ecologically, economically and socially sustainable world with a sense of responsibility, perceives and evaluates itself and others in terms of the current situation.

Sustainable Development in Turkey

In sustainable development education, individuals become aware of the fact that environmental and social sustainability is a global goal and gain the necessary knowledge, skills and perspective. In addition, with education, individuals are aware that they should not use the resources of nature as if there is no end, and they are aware that they should also consider the environment in their production activities. The existence of individuals, who act in accordance with the goals of sustainable development, exhibit positive behaviors related to the concept in question, and make the goals of sustainable development a lifestyle, is possible with effective sustainable development education (Atmaca, 2018; Aytar, 2016; Aydoğan, 2010)

Education for sustainable development ensures that individuals, institutions and organizations, societies and states act with the awareness of sustainable development and it increases the level of welfare by offering people a healthier, safer world. For sustainable development, individuals can have a new perspective for sustainable development, creative and critical thinking skills to develop methods and technologies and they get awareness of sustainable development. Education should not be regarded as a system given only at schools. In this context, training should be given to all public institutions and organizations within the scope of sustainable development, and awareness of sustainable development should be increased.

Sustainable development is a multifaceted structure and is concerned with the environmental, economic and social consequences of human activities. Adults' understanding of the importance of education for sustainable development is very important for young individuals to gain a positive understanding. With sustainable development education, individuals gain knowledge, skills and values and have higher living standards without harming the planet they live in (Atmaca, 2018).

The basic value of education for sustainable development is stated as respect. This is the respect that present and future generations should have for the world, for the people of the world, or for all the blessings the world has given to people. Sustainable development education is about teaching individuals what needs to be done to make the world a safer, healthier, more productive and fairer world than it is now, and to raise individuals who are aware of their rights and responsibilities. Sustainable development education should

not be considered as a database containing only information about the environment, society and economy. In addition to the knowledge in these areas, the behaviors, skills, perspectives and values required for individuals to lead a sustainable life for generations, and the identification of the causes and solutions of the problems that prevent the realization of sustainable development, are within the scope of sustainable development education. In this context, for the realization of sustainable development, the education system and curricula must comply with the fundamentals and principles of sustainable development. For this reason, the current education system and curricula should be carefully examined, the content and scope of the curriculum should be examined, the compatibility of the knowledge, skills and acquisitions to be gained should be discussed, and it should be determined what should be included and excluded from the scope of the curriculum. The current education system and curricula should be revised according to the principles of sustainable development. In this way, an appropriate education system and curriculum should be obtained for sustainable development education (McKeown, 2002).

Environmental awareness, nature protection, sustainability approach have started to create an agenda in Turkey. Turkey's interest in the environment goes back to the 1970s. In 1978, Prime Ministry Environment Undersecretariat was established to follow the developments both in the country and in the world related to sustainable development and the environment, so this took place on the agenda as a state policy (Erkol, 2019). In Turkey, there are many laws, regulations in constitutional and legal dimensions for the protection of nature and nature-friendly organizations and sustainable development. Environmental protection law, which was included for the first time in the constitution that was amended in 1982, took place in the constitutional dimension for the first time (Budak, 2000). While emphasizing the importance of environmental protection and environmental health in this constitutional arrangement, it did not mention the factors that should and should not be in an ideal environment. In fact, it seems that the outline of the environmental protection law was not fully drawn. In addition, it is seen that the concept of "sustainable development" is not clearly expressed in this constitution (Egeli, 1996). The environmental protection law in 1983 addressed the environment as a whole. It was pointed out that it is not only important to prevent environmental pollution with wastes to be thrown into the environment, but also protect existing natural resources and manage the soil correctly. In 1986, a regulation was made for the purpose of controlling Air Quality and preventing air pollution. A regulation was made to prevent noise pollution and to minimize the damage it causes to people. Again in 1988, a regulation for water quality control was made. In the following years, regulations were made on medical waste control and harms of toxic chemicals and assessment of their environmental effects (Okumuş, 2002).

Apart from the regulations, there have been many national and international arrangements in Turkey. Convention for the Protection of the World Cultural and Natural heritage is the first international agreement signed by Turkey. Later, the Protocol on Substances that Deplete the Ozone Layer (Montreal) was signed. Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Biological Diversity and Convention to Combat Desertification are international conventions signed chronologically. Some of the regional agreements are The Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona) and The Convention on the Conservation of European Wildlife and Natural Habitats (Arat et al., 2002).

In the five-year development plans published by the State Planning Organization (SPO), the changes and developments taking place in the name of sustainable development in Turkey are followed. For the first time in Turkey, an environmentally friendly conservation plan was put on the agenda in the 3rd Five-Year Development Plan. The first development plan (1973-1977) started to take place in development plans for the first time as an indicator of the increase in environmental attitudes and sensitivity in Turkey in the period after the Stockholm Conference (1972) (Egeli, 1996). In the 1979 Year Program published in the Official Gazette in 1978, it was accepted as a principle to create an environmental pollution inventory for Turkey, but the preparation of a status report and the collection of environmental documents after the decree took place in 1991 after the establishment of the Department of Environmental Inventory under the Ministry of Environment (Erkol, 2019).

Studies on education for sustainable development in Turkey are carried out by the Ministry of National Education, the Ministry of Environment and Forestry and non-governmental organizations. These education and training activities are carried out in order to enable individuals to realize the relationship between society and the environment and to develop awareness of social, economic and environmental sustainability. Turkish Environmental Education Foundation (TÜRÇEV), a non-governmental organization, aims to provide sustainable development education in pre-school education institutions and primary schools with its different projects. While students involved in projects such as Eco-Schools, Forest in Schools, Young Spokespersons of the Environment gain information about sustainable development, they also raise awareness of their environment (Kanmaz, 2019). In addition, TÜBİTAK Science and Society Projects Support Program applications are among the studies related to sustainable development education and environmental education (Sütgibi, 2018).

UNESCO Turkish National Commission established a committee on education for sustainable development. This committee examined the technical and policy dimensions

of education for sustainable development. In the Turkey Sustainable Development Report (Ministry of Development) prepared for Rio+20, attention was drawn to the strong connection between education and sustainable development. It is mentioned about the awareness of the courses to be applied about the environment and sustainability in Turkey (Teksöz, 2014).

The most important example showing that the concept of sustainable development has been integrated into the education system is the Primary School (3, 4, 5, 6, 7, 8th Grades) Science Course Curriculum (MEB) prepared in 2013. The purpose of education for sustainable development is stated in the Science Course Curriculum prepared in 2013 as "recognizing that the environment and society are a whole and developing the awareness of sustainable development" (Teksöz, 2014).

There are also activities carried out by non-governmental organizations in Turkey. For example, forest in schools, young spokespersons of the environment projects and Turkish Environmental Education Foundation (TÜRÇEV) in pre-school education institutions, Eco-Schools, environmental awareness, sustainable development education and environmental education in primary and secondary schools are some of the non-governmental organizations (WEB 3). According to Teksöz (2014), for the realization of education for sustainable development;

- Education priorities for ESD in Turkey should be determined.

- Targets related to these priorities and project topics related to these targets should be determined.

- Education center should be established for sustainable development.

- The Ministry of National Education (MNE), Ministry of Environment and Urbanization (MoEU), Ministry of Water and Forestry (MWF), UNESCO Turkey, local governments, Non-Governmental Organizations (NGOs) and universities should be located in the center of ESD.

- All projects related to ESD should be carried out and recorded from this center.

- Schools should prepare their own ESD projects.

- Good projects should be rewarded.

- They should be shared and developed internationally (Dal, 2020).

Conclusion

In order for sustainable development to take place, individuals with an understanding

of sustainable development should be raised. Raising individuals with a sustainable development understanding will be thanks to teachers with a sustainable development understanding (Çobanoğlu & Türer, 2015).

If we want to raise individuals with sustainable development awareness, educators in all fields must be individuals with sustainable development awareness. Teacher candidates who continue their undergraduate education in science education faculties are the educators of the future to whom we will entrust our children. Science education faculty students, who are the teachers of the future, are the people who will raise our future generations. Education process should be realized in accordance with its purpose and efficiently, the individuals who provide the education should have awareness about the field they teach, and therefore their knowledge, skills, values and behaviors related to that field should be ethical and sufficient. In this context, in order to raise individuals with sustainable development awareness, it should be ensured that teacher candidates who have chosen teaching as a profession and who are studying at science education faculties should approach teaching profession as individuals with sustainable development awareness when they graduate from their undergraduate programs (Atmaca, 2018).

Teaching education given in science education faculties is of great importance for sustainable development. It is the teachers who will ensure that the sustainable life style becomes widespread. For this reason, education programs in all higher education institutions, especially in science education faculties, should be arranged according to the principles of sustainable development. The education program to be given to teacher candidates in science education faculties should be of a quality that will serve the purpose of sustainable development. (Demirbaş, 2015).

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About Author

Hayriye Nevin Genc is currently an associate professor of science education at the Necmettin Erbakan University. Her research focuses on education and chemistry. She has many articles in different international journals and teaches undergraduate students about sustainable development at the Necmettin Erbakan University. Email: nnevin85@ hotmail.com, ORCID iD, https://orcid.org/ 0000-0003-3240-0714, ResearchGate https:// www.researchgate.net/search?q=hayriye%20nevin%20gen%C3%A7

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SECTION 3
EDUCATIONAL TECHNOLOGY

Distance Education

Ismail Coskun
Ministry of National Education

Cavide Demirci
University of Eskisehir Osmangazi

The Definition and Importance of Distance Education

In today's world, with the development of science, new technologies have entered into the our lives. These technological developments are rapidly changing the environment of education and training. In the field of education and training, time and place boundaries have begun to disappear. Thus, distance education entered the literature and took its place in the education systems of countries (Keegan, 2005). Today, distance education has an important role in the education systems of countries. This role has vital both for its own citizens and for foreign countries. The following features of distance education, which has taken its place in the basic education policies of many countries for many years, draw attention.

• Lifelong learning

• Use of technology in education

• Providing of training at affordable costs

• Individualization of educational activities

• Having the training at the desired time

• Dignity parity for men and women

• The prestige parity of qualified and higher education

• The globalization of education (Keegan, 2005).

Considering these properties of education, various definitions of the concept of distance education, which are realized through correspondence in the past and with advanced technologies today, are made. Simonson and Schlosser (2002) define distance education as a formal education in which the learner and the teacher are in separate places, but in which students, educational resources and teachers interact through interactive telecommunication systems. This definition consists of four main components. The first concept is that distance education is institutionally. The second component of the definition of distance education is the concept of separation of the teacher and student.

Generaly, separation is thought of in geographic terms - teachers are in one location and students in another. Interactive telecommunications is the third component of the definition of distance education. The interaction can be synchronous (simultaneously) or asynchronous (at different times). Interaction is critical, but not at the expense of content. In other words, it is important that learners be able to interact with each other, with resources of instruction, and with their teacher. Finally, is the concept of connecting learners, resources and instructors. This means that there are instructors that interact with learners and that resources are available that permit learning to occur. Resources should be subjected to instructional design procedures that organize them into learning experiences that promote learning, including resources that can be observed, felt, heard, or completed. Briefly, the definition of distance education includes these four components. If one or more are missing then the event is something different, if only slightly, than distance education. (Simonson & Schlosser, 2002).

Institutionally Based on	The separate of Learner and The Teacher
Interactive Telecommunication	The sharing the data,voice, image Learning Experienaces

Figure 1. Four Components of Distance Education Definition (Simonson et al., 2008)

Unesco (2002) has defined distance education as an educational process in which a significant part of education is carried out separately in terms of space or time. Distance education is a planned learning method that normally takes place in a different place than face to fece education. For this reason, a course design carried out with distance education requires special techniques, individual teaching techniques, special electronic and technological communication methods, and special organizational and administrative arrangements (Moore & Kearsley, 1996). According to Bates (2005), distance education is less a philosophy and more a method of education. Students can study at the time when they want, in the place where they prefer , and without meeting with a teacher face-to-face. For example, they can study and learn something new at home, at work, at school, in the library or in a study center with a technology tool. Here, technology is a critical element of distance education. It is important to use tools such as satellite, video, sound, graphics, computer, multimedia technology in distance education. In this

education system, the use of electronic tools or written materials and similar materials is the basic approach to reach students.

Rıza (1997) defines distance education as activities carried out by systematically using specially prepared written, visual, mass communication programs and short-term face-to-face teaching regardless of the age, time, place, method, objectives and limitations of traditional education. According to Uşun (2006), distance education is a planned and systematic educational technology application which the tecaher and the students are in separate environments in most of the learning-teaching activities; which the opportunity for "individuality", "flexibility" and "independence" are provided for the recipients in terms of of teaching age, goals, time, place and method, etc. ; which materials, tools and technologies and methods such as written and printed materials, audio and visual tools, technologies, face-to-face education are used in learning-teaching processes; which the communication and interaction between the source and the receivers are carried out with interactive integrated technologies. Özkul and Aydın (2012) on the other hand, open and distance education is the learning process, which learners are distant from each other and learning resources in terms of time and space; which their interactions with the students and learning resources are based on distance communication systems.

When the literature on distance education is examined in general, although there are many definitions of distance education, there are common points in the definitions. It is noteworthy that distance education is an institutional-based formal education process, learners and teachers are separated in space and time, specially designed study materials and teaching methods are used in this education system, new technologies are used to connect students taking distance lessons, teachers and institutions and to provide two-way communication as well as facilitating teaching and learning. Keegan (2000) analyzed each of the definitions of distance education and revealed five basic features of distance education. These features are listed as follows:

• During the learning process, the teacher and the student are in different places.

• The influence of the educational organization is vital, both in the planning and preparation of learning materials and in the provision of student support services.

• There is a need to use printed, audio and visual tools to convey the content of the course to the learners by providing communication between the teacher and the student.

• It is necessary to provide two-way communication in order that the student can start learning activities.

• The learning process takes place in the form of individual learning rather than

group learning that occurs in face-to-face education.

One of the important factors affecting the development of today's societies is education. Therefore, countries all over the world have to give their students in primary, secondary and higher education by using the best educational activities. On the other hand, it has to take care of providing education opportunities in various ways to individuals who cannot continue their education at any school level and to the personnel who are on the job (İşman, 2011). Since it is very expensive to reach all citizens of a country through face-to-face education, it has to reach them with cheaper tools and methods. In our age, the most important method to meet this need is distance education (Kaya, 2002).

Distance education is not a simple system or component. Converting an institution to distance education or creating a new distance education institution means making significant changes in the use of teaching resources. While doing this, politicians and experts should carefully consider how and why they will implement this system (Moore and Kearsley, 2012). These responsible people should establish the philosophical foundations on which distance education is based, and put the principles and methods of the system into practice (Biao, 2012). Moore and Kearsley (2012) explain the importance of distance education with the following sentences:

- With distance education, it is possible for people of all ages to access education and learning activities.

- With lifelong learning, people update their professional knowledge and contribute to their individual development.

- It is ensured that the cost of scarce educational resources is reduced.

- The quality of existing education structures is improved.

- Large masses are reached by increasing the capacity of the education system.

- Inequalities between age groups are eliminated. With this system, all age groups are reached.

- It is ensured that educational campaigns reach certain target audiences.

- The developments in new subject areas are followed and the training and teaching capacity is increased.

- It contributes to the integration of education with work and family life.

- An international dimension is added to educational experiences.

Since there is no time and place limit in distance education, individuals can access

unlimited resources whenever they want, they can get online or offline education with the tools they want. For this reason, time, duration and place limitations are eliminated in distance education (Kılınç, 2015). Since the student is in an independent state, he determines the organization, place and time of teaching activities in line with his own interests and needs. In particular, individuals choose learning-teaching activities in a way that they can learn on their own. Thus, personal learning needs are meet (Arat and Minister, 2011).

Today, formal education is insufficient to meet the educational needs of individuals. In this case, distance education emerges as an alternative and sometimes as a complement to formal education. In particular, students' repeating the subjects they cannot understand at school, accessing additional resources by using information tools such as printed texts, TV broadcasts and other audio-visual tools reveals the necessity of distance education (Tırnovalı, 2012). In this context; the student enables autonomous learning by making use of different sources,by reach to different people , by making his own personal learning plan and improving his self-direction capacity (Moore & Kearsley, 1996).

The most important requirement of distance education is that it makes educational activities possible for individuals who cannot benefit from formal education due to cultural, religious, political, war and immigration reasons (Weimin, 1999). On the other hand, it gives the chance to continue their education to individuals who leave any level of formal education for various reasons. In order to solve this situation, countries support their distance education infrastructures and provide the course materials of their citizens free of charge (Tırnovalı, 2012).

Today, since high-tech informatics and electronic tools are used in distance education, it is possible to reach thousands of people at the same time, to meet, to perform teaching activities and to interact (Balaban, 2012). As a result, virtual classrooms are created, web services are provided, open education high schools and open education faculties are established. In this case, the education expenditures of the countries decrease and they achieve their educational goals at a more affordable cost (İşman, 2011).

Adults have to give importance to their personal and professional development in order to meet their individual needs throughout life. Therefore, individuals participate in various courses, vocational and educational programs throughout their lives in order to keep their professional knowledge up-to-date and improve their personal development (Gökkaya, 2014). These educational activities are carried out through distance education as well as non-formal education institutions. Thus, these in-service training activities carried out with modern methods are inexpensive for both the employer and the individuals and they are organized at a convenient time for the individuals (Duman, 2019).

Historical Development of Distance Education System

Although distance education seems to be an advanced system today, it has a history of 150 years (Kaya, 2002). The origins of the techniques and some of the most important ideas we use in distance education today based on events that took place in the world more than a century ago. Many developments, different inventions, ideas and practices taking place in different parts of the world have contributed to the development of distance education (Moore & Kearsley, 1996). Thus, distance education went through various stages in parallel with the development of technology until it reached its modern level. Today, distance education is widely used in different countries of the world (Moore & Kearsley, 1996).

Moore and Kearsley (1996) divided the history of distance education into five important phases, depending on the communication environment and the developments in communication technology that made it possible to use new tools and equipment. We can also describe this development as a generation. These five generations are as follows:

1. Correspondence

2. Radio and television broadcasting

3. Open universities

4. Teleconference

5. Internet / web

1. Correspondence

Distance education via correspondence relied on printed or written text as a means of communication. Courses were sent to students via letter. At periodic intervals, students wrote their assignments and sent them to the teachers. Teachers were giving feedback by commenting on assignments and sending the assignments back to the student. The technology used was limited. Correspondence materials were printed and reproduced. Postal service was used as a way of communication (Kember, 2007). The chronological order of distance education applications via correspondence carried out in the world is given in Table 1.

Table 1.Chronological Order of Distance Education Applications Via Correspondence in the World

The Date	Distance education applications via correspondence
1833	The first distance learning by letter took its place in history with an advertisement titled "Composition by Mail" published in a Swedish newspaper.

1840	In England, Isaac Pitman, a stenographer, began teaching shorthand by letter in Bath. In this training, the achievements of the students were also evaluated with a grade.
1843	Three years later, this training was formalized with the founding of the Phonographic Correspondence Society, pioneered by Sir Isaac Pitman.
1856	The first institution to teach languages through distance learning in Berlin was founded by Charles Toussaint and Gustav Langenscheidt in Germany.
1873	After Anna Eliot Ticknor encouraged the society to study at home, a Boston-based distance learning activities spread across the Atlantic. Thousands of students were reached with guidance studies, test-solving and reading activities.
1878	In 1878, Skerry's College was established in Edinburgh, which was engaged in Correspondence studies.
1883-1891	Students who completed the required institutes and correspondence courses were awarded academic certificates by the state of New York through the Chautauqua College of Liberal Arts. The summer courses continued effectively.
1887	Many correspondence institutions were established, such as the University Correspondence College in London.
1891	Thomas J. Foster, editor of the Mining Herald, a daily newspaper in eastern Pennsylvania, began teaching a correspondence course on the prevention of the mining and the mine accident.
1892	The University of Chicago established departments offering distance education at the undergraduate, graduate, and doctoral levels.
1898	Hermod founded International Correspondence Schools, a commercial school under his own name, one of the largest and most influential distance learning organizations in the world. This was a high school which practiced by Correspondence and had thousands of students.
1920	Curriculums started to be developed in secondary schools providing distance education.
1926	Michigan offered vocational courses to students in Benton Harbor through distance learning by Correspondence.
1932	The University of Nebraska offered its first distance education courses with correspondence in high schools.
1939	In France, the Ministry of Education established the correspondence-teaching college in response to the impending World War II.

(Adapted from Simonson et al., 2008).

The target groups of this period, in which distance education efforts took place with correspondence, were adults with professional, social and family commitments. The target groups of this period, in which distance education efforts were made by letter, were adults with professional, social and family commitments. This remains the main

target group today. The aim of distance education is to broaden the intellectual horizons of individuals, to improve their professional knowledge and to inform them about current developments. Moreover, individuality and time flexibility in education through correspondence were important considerations (Simonson et al., 2008).

2-Radio and Television Broadcasting:

Radio or television is a form of one-way communication used as a broadcast medium. Radio and television broadcasting has been a significant informal learning tool.The reason why these communication tools are preferred is that although they are expensive broadcasting tools in the first years, they are cost-effective in later years and have the opportunity to reach many people (Kember, 2007).

All over the world, distance education institutions have used radio and television to broadcast distance education courses. Many countries have started to provide distance education programs on their own national state radio and television over time and have had the opportunity to reach their citizens living in different geographical regions (İşman, 2011). Distance education applications carried out through radio and television are given in Table 2.

Table 2. Distance Education Applications Carried out Through Radio and Television

The Date	Distance Education Applications via Radio and Television
1895	Radio technology was invented.
1910	Radio broadcasts started broadcasting in the USA, and started to make licensed programs 2 years later.
1916	Distance education courses were given at the University of Wisconsin in the USA. Students completed their lessons by listening to the radio at certain times of the day.
1920	By establishing radio stations in the USA, distance education courses became widespread and reached large masses.
1920	In 1920, the British Ministry of Education supported education with radio lessons, and the state's official radio began teaching activities with BBC radio programs.
1929	China supported the distance education system through radio and contributed to millions of people by giving distance education courses.
1930	Radio was used in distance education systems in Canada and Australia.
1932	In the USA, television channels started to implement distance education programs at the state universities of Lowa and Kansas.
1938	In the USA, lecture presentations began to be made on television.
1945	John W. Studebaker established the first educational television.

1950	Colleges and universities started to establish educational television stations and became widespread in educational institutions.
1957	New York University designed educational programs in collaboration with the CBS television company.
1961	Japan, Russia, Czechoslovakia, Hungary used the distance education system at the university level through television for the first time.
1966	The French Ministry of Education carried out its educational activities through television.
1980 and after	Many countries in the world have expanded their distance education programs with their national radio and television channels and established radio and TV channels only for distance education. In this way, they have continued to reach millions of people.

(Adapted from İşman, 2011; Simonson et al., 2008).

3-Open Universities

Open universities are quite different from the other four generations in that they did not arise due to the development of a particular communication medium. Instead, it is characterized by the use of a combination of media and supporting services. The defining feature of the distance education model, which includes the use of open-circuit broadcasting, is a package of course materials, which is the main means of conveying knowledge to the students (Kember, 2007).

Today, distance education in open universities has reached a higher standard of educational design and has become a multimedia package rather than purely print-based. The open university model is also an important development as it offers much more than a network of supporting materials and advisory services for correspondence work. In time, the use of communication technology has also increased to provide support for the educational studies (Kember, 2007).

The UK Open University, the world's first open university, was established in the UK in 1969. In addition, distance education was given at South Africa University and at various universities in Japan and Australia. The universities in these countries have achieved great success and established open universities (Moore & Kearsley, 1996). Today, there are millions of people who receive distance education in open education universities in different countries all over the world (İşman, 2011).

4.Teleconference

The most important defining feature is the use of telecommunication channels for the instructor and students to interact. The most important feature of this system, which is closer to traditional primary teaching, is that the students listening to the lesson are

not physically present in the classroom, but are connected via a teleconference channel (Kember, 2007). The teleconferencing system was first used in the 1970s and 1980s. Unlike radio and television broadcasting, there is a two-way communication. The teacher communicates with the student at the same time, even though they are in different places. He gives feedback by having interaction with the student (Moore & Kearsley, 2012). This system has gained four different teleconferencing features over time. The teleconferencing system developed with the technologies which include sound, audio graphics, video and computer units and became widespread all over the world (Moore & Kearsley, 1996).

5. Internet / Web

Fifth generation distance education is internet and web-based teaching. In the late 1980s and in the early 1990s, the development of fiber optic communication systems allowed the expansion of live two-way communication. High quality audio and video systems were developed. Thus, computer and internet technology became widespread all over the world (Kember, 2007).

Distance education opportunities increased rapidly thanks to the use of computers and the internet.

In the mid-1980s, the universities started to offer credit and non-credit courses online (Moore & Kearsley). Today, in most cases, the teacher organizes course materials, readings and assignments online. On the other hand, the students read course assigments, watch videos, listen to recordings, complete their homework, and participate in online discussions with other classmates (Simonson et al., 2008).

Computer networks are an easy way to supply course materials to students around the world. Now, many lecturers and teachers use the useful interface of the World Wide Web to make course materials available to their students (Moore & Kearsley, 1996). In addition, Massive Open Online Courses (MOOCs) are well-designed and college-level courses for anyone who want to enroll online. Today, MOOC courses are huge, often tens of thousands of people enroll in this system. Later, individuals can participate in MOOCs online and offline (Simonson et al., 2008).

Historical Development of Distance Education System in Turkey

Scientific and technological developments in the world in the last century have affected the education systems of countries. In the rapidly developing world, countries have taken measures for their own people to follow these developments and to benefit from this knowledge whenever they want (Balaban, 2012). In order to achieve this goal, face-to-face education was not enough for people and they had to resort to distance education.

Because, in order to reach both young and adult populations, it has become necessary to reach large masses with various technological communication tools that eliminate the problem of time and place (İşman). In this context, Turkey, like many countries in the world, did not remain indifferent to this situation and carried out a series of necessary studies. But; It took a long time to establish, develop and disseminate distance education systems in our country (Şahin, 2017).

In light of the event and important developments, Bozkurt (2017) classified the developmental periods of distance education in Turkey into four periods: 1-Conceptual period, 2- Correspondence, 3-Radio-television, and 4-Internet-Web. While determining these periods, developments in the fields of technology and education and the regulations and laws that were put into practice in Turkey were taken into consideration.

1. Conceptual Period (1923-1955)

This period covers the period when the discussions and suggestions about distance education were made in Turkey. In this period, the Republic was established and the law of unification of education was put into practice in 1924 and education activities was guaranteed by law for everyone to benefit from. It is aimed that all citizens are literate with this educational law (İşman, 2011). It was suggested that John Dewey, who came to Turkey in the same year, should use letter teaching in the training of teachers. Thus, even if it is only a suggestion, some steps were taken for the first time to benefit from distance education (Kılınç, 2015).

In 1927, problems related to education were discussed in the Grand National Assembly of Turkey, and the idea of distance education was put forward by Mustafa Necati Uğral, the Minister of National Education. In this session, the use of distance education in order to increase the literacy rate of the people was discussed. But; it could not be put into practice since the literacy rate was very low in the current period (Şahin, 2017). As a result of various researches carried out in 1933, the idea of implementing correspondence teaching courses were put forward by taking into the consideration the conditions of the country. In 1939, the National Education Council held a meeting for the first time, and the idea that distance education activities could be carried out besides the formal education began to dominate (İşman, 2011). In 1941, in order to train villagers living in rural areas, 'Agricultural Calendar' and 'Home Hour' programs were put into practice in order to meet the educational needs of women (Bozkurt, 2017).

After 1950, more concrete projects were proposed on distance education projects. In 1950, Ankara University Banking and Commercial Law Research Institute suggested using distance education methods in education (Kılınç, 2015). The Educational Films Center was established in 1951 and the establishment of technology in the education system was the beginning of an active process in distance education (Bozkurt, 2017). In

1952, radio broadcasts began to be made in Istanbul to support agriculture and animal husbandry for farmers (İşman, 2011). At the end of 1953, FONO foreign language courses were put into practice for the first time by correspondence and as a distance education method.

2. Correspondence (1956-1975)

In this period, distance education studies have ceased to be a suggestion and an idea, various implementations have been made in our country through trial and error. The foundations of institutions serving today were laid. However, the desired success could not be achieved due to political instability and inadequate infrastructure (Bozkurt, 2017).

In 1956, Ankara University, Faculty of Law, Banking and Commercial Law Research Institute started the distance education practice in Turkey. With this application, it is aimed to give training to the employees in the bank by correspondence. Bank employees were sent instructional materials about banking (Şahin, 2017). In 1957, the 6th Education Council was held and the subject of non-formal education was discussed in detail, and suggestions were made about the aims, principles, methods, tools, implementers of the system and the audience it would address. After this meeting, there was an increase in distance education implementations (İşman, 2011).

In 1958, an important development occurred in the Turkish education system. A correspondence Teaching Center was established under the Ministry of National Education. Courses were given by correspondence to those who wanted to finish school from open education (Bozkurt, 2017). In 1961, the Ministry of National Education, the Undersecretariat of Vocational and Technical Education established the "Correspondence Teaching Center" to carry out studies on teaching various technical subjects by Correspondence. With this system, it has started to offer various courses to give students a certificate of authority (Kırık, 2014). Later, the programs of all departments of Three-Year Education Institutes, the Girls' Technical Higher Teacher Training School, the Boys' Technical Higher Teacher Training School, and the Commerce and Tourism Higher Teacher Training School were put into effect. These programs had approximately 50 thousand students in the 1974-1975 academic year (Kaya, 2002). Correspondence Teaching Center was affiliated to the Non-formal Higher Education Institution, which was established in 1975 with the approval of the Ministry. The aim of the Non-formal Higher Education Institution (NHEI /YAYKUR) is to train individuals who are needed by our society for students who have graduated from high schools or equivalent schools and cannot enter an undergraduate program (Şahin, 2017; İşman, 2011). The aim of the Non-formal Higher Education Institution (NHEI/YAYKUR) is to educate students who have graduated from high schools and equivalent schools, but who do not have the opportunity to enter a higher school and undergraduate program, as individuals needed

by our society in line with the development plans and goals of the state (Şahin, 2017; İşman, 2011).

In 1962, the training unit was established with Radio. In 1964, educational broadcasts began to be made in a planned manner with the radio channels of the Turkish Radio and Television (TRT). In 1974, in parallel with the developments in technology, TRT opened different radio channels. In addition, TRT 1 started to broadcast education, TRT 2 started to broadcast culture, and TRT 3 started to broadcast music broadcasts. In addition, "School Radio" and "Foreign Language Lessons" programs were put into practice to support formal education in cooperation with the Ministry of National Education (Bozkurt, 2017).

3. Radio, Television (1976-1995)

This period is a period in which the maturation of distance education studies accelerated in Turkey and distance education applications became widespread in primary, secondary and higher education. This is a period in which audio-visual technologies are used besides the printed materials. It is a period when education programs for the interests and needs of individuals became widespread by putting into practice the efforts to ensure the equality of opportunity of the citizens (Bozkurt, 2017).

In 1968, the name of the Letter Education Center was changed to the Radio and Television Education Center after the widespread use of radio and television in the country. In 1982, this institution was called as Information Center due to the use of modern tools in education (Kırık, 2014). In the 1980s and 1990s, the School radio and TV school, which served in schools affiliated to the Ministry of National Education, carried out activities supporting formal education and non-formal education (Bozkurt, 2017).

In the 1980 constitution, with the regulations made in 1981 and 1982, the right to lifelong education and open education was transferred to the higher education institution and Anadolu University. In the academic year of 1982-1983, Anadolu University, which has been using distance education applications since 1970 and has academic and technological infrastructure, started distance education programs in the field of Economics and Business Administration (Kaya, 2002). In 1986, Anadolu University organized distance education activities for Turkish citizens living in Western Europe. In 1991, Fırat University started to organize educational activities by establishing a television station within its own structure. In addition, in the same year, it gave graduate students the opportunity to complete their education via e-mail service (İşman, 2011).

1992, the Ministry of National Education established the open education high school. Thus, people who could not continue their high school education due to various reasons were given the opportunity to complete high school and receive a diploma. Open education

high schools, which have been operating according to the passing and credit completion system in field and culture courses since 1992, were transformed into multi-program high schools that implement vocational education in the 1995-1996 academic year. In this context, the Ministry of National Education provided course materials support to the students and Turkey Radio Television (TRT) also supported the students by offering various educational programs for these students (Bozkurt, 2017; Kaya, 2002).

4. Internet-Web (1996-Present)

It is a period in which information-based education activities are active. In this period, the use of audio-visual learning contents, tools and learning environments became widespread in distance education activities. In addition to the use of one-way tools in learning processes, two-way interaction and communication has been realized (Bozkurt, 2017). In the learning processes, two-way interaction and communication were realized besides the use of one-way tools, (Bozkurt, 2017). In this process, many public and private institutions have started to train their own personnel, give private lessons to students and organize educational activities. The use of multimedia, video, videotext, interactive video, telefax, teleconference systems, educational technology laboratories, teaching machines, robots, databases has become widespread in distance education (İşman, 2011).

An important development in this period was the establishment of the Open Education Primary School by the Ministry of National Education in 1997. Those who have completed the age of 15 and those who have left the 6th, 7th, and 8th grades of primary education have benefited from this distance education system. In the same year, Vocational and Technical Open Education School was established. The purpose of these institutions is to prepare individuals for life by providing them with a profession by giving face-to-face training when necessary (Bozkurt, 2017).

Today, universities have started to establish distance education centers (DEC) by preparing the necessary technological equipment and infrastructure. Many universities have started to offer certificates to their students by giving various courses and lectures via e-learning. In addition, most universities offer diplomas by opening associate degree, undergraduate, graduate and doctoral programs to their students through distance education. In recent years, Anadolu University has given the public the opportunity to complete a second university. In summary, many universities develop projects to continue their educational activities with information technologies (Bozkurt, 2017; İşman, 2011).

In Turkey, distance education activities at the basic and secondary education level have accelerated with the implementation of the FATIH project. Therefore, parallel to the developments in the world, the Ministry of National Education has has made new initiatives. In 2010, the Ministry of National Education, in cooperation with the Ministry

of Transport, initiated the project called "Movement to Increase Opportunities and Improve Technology", known as FATİH in short in Turkish. (Kayaduman et al., 2011). FATIH Project in Education was initiated for the effective use of technology in lessons in order to provide equal opportunities in education and training by improving technology in all schools all over the country. Information technology tools are arranged to appeal to more sense organs in the learning-teaching process in the clasrooms and at the other parts of the school. The students have access to millions of written, audio-visual content both inside and outside the school, and online lessons are given by teachers thanks to the Education Informatics Network (EIN) established by the Ministry of Education. During the pandemic, which has had an impact all over the world, online courses were held all over the country through EIN. In this context, many course materials have been made available to teachers and students. In addition to the opportunities provided to students with the FATIH project, it provides the opportunity to organize face-to-face and distance in-service training activities for teachers (YEGİTEK, 2020).

Distance Education Examples in the World

In this section, it will be focus on the distance education system of the UK, China, India and Australia. There are several reasons why we consider these countries. The main reason why we consider the distance education systems of the countries named above is that the open universities in these countries reach very large masses through distance education. According to Qayyum and Zawacki-Richter (2019), the number of students enrolled in open universities in these countries as of 2019 is as follows:

Table 3. The Number of Students Enrolling in Open Universities in Australia, China, India, England as of 2019

Country	The number of students enrolled in open and distance education
Australia	261 000
China	6 450 000
India	4 200 000
England	173 000

There are two important reasons why we consider the distance education system in Australia. The first is that Australian universities are at the forefront of promoting the use of open educational resources (OER). The country's leading universities, such as Charles Sturt University, the University of Tasmania and the University of Technology, and the Higher Education Board of the Australian Government's Department of Education and Training (Student Information and Learning Department), are developing a National Roadmap to support distance education policies. Another reason for choosing this country is that Australia has the students online courses at the level secondary and high shool. Open and Distance Education Institutions in Ausralia provides online courses

simultaneously for those who cannot attend primary and secondary school due to geographical reasons, those who have to travel nationally or internationally with his family in the long term, those who enroll in a full-time school but cannot take the courses they want as they continue artistic and sports activities, and those who have a long-term illness (SIDE, 2020).

The reason why we examine the distance education system in China and India is that they are the two most populated countries in the world. The population of China is 1,439,254,046, and the population of India is 1,380,004,385 (Wikipedia, 2020). It is a matter of curiosity that these countries, which have a large population, provide education and training services to all citizens through distance education. Because, the distance education network established to reach such a large population will cause high costs and require a great deal of effort. That these countries use the technological infrastructure and networks to deliver educational activities to their students and citizens will also be a guide for us in the future educational work.

In Europe, distance education has made significant progress in recent years. In distance education activities, England has an important place in addition to countries such as Germany, the Netherlands, Portugal and Spain. Europe is one of the places where the trend towards dual mode service delivery (part-time face-to-face, part-time distance learning) is most evident. This trend is also strongly highlighted in the UK, where most universities now run distance learning programmes.

The prominence of these distance education programs is due to the individual initiatives of faculties or departments. In the UK, undergraduate and postgraduate education programs given by distance education to people other than their own citizens are also very common (Harry, 1999). For this reason, in this study, the widespread use of distance education at undergraduate and postgraduate level in the UK, a European country, will support better elaboration of the research subject.

Distance Education In The United Kingdom (UK)

Distance education in England is conducted by the Open University of England, which was established in 1969, which provides education to large masses. This university had of great importance in terms of being the first institution in the country, coming to the fore with its special structure and working methods, and being recognized internationally (Peters, 2006). The headquarters of this institution was opened in the town of Milton Keynes in January 1971. The main purpose of this institution, which is not an academic prerequisite for enrollment in the Open University, is to provide educational opportunities to everyone. The education of this university was carried out with courses organized centrally by a distinguished faculty, television, correspondence, study groups and courses and seminars held in different geographical centers of England and various

activities. However, correspondence supported by television lectures and seminars was used as a basic educational technique in distance education (Britannica, 2020). In 1983, the doors of the Open University Business School, which today is the largest business school in Europe, were opened. In the 1990s, distance education became widespread, with new fields of study and new undergraduate programs opening, including law and modern languages in Open university UK (Open University, 2020).

Today, the Open University of England offers undergraduate and postgraduate degrees. In addition, more than half of higher education institutions offer various online and offline courses via the internet at associate, undergraduate and graduate levels (Open University, 2020). Through the open university, teachers are provided with in-service training courses and school-oriented courses for self-development as well as individual study packages. In addition to individual study packages, different courses are given to health and public employees to update their technological knowledge. The common goal for distance education is to focus on professionals who want to recertify, employees who want to update their job skills, people with disabilities and active military personnel (Encyclopadia Britannica, 2020).

The UK does not have national policies regarding distance education for other states to benefit from. However, there are a number of factors and policies on distance education for its own people. Due to the immigration problem, universities have encouraged international students to attend distance courses that they can complete in their home country (Open University, 2020).

The British Accreditation Council, Quality Assurance Agency (QAA), which is responsible for the quality assurance of the higher education sector, does not make a distinction between face-to-face education on campus and distance education (Boampong & Holmberg, 2015). The Open University deals with some of the important issues facing the world today, informing the public and politicians, and encouraging discussion and participation on questions of global importance. Thus, the Open University of England continues its educational activities worldwide with the quality of education (Open University, 2020).

Distance Education in China

With the advancement of science and technology in the People's Republic of China, it has given great importance to distance education and has made significant developments recently. Working adults, school leavers and some disadvantaged groups want to continue their education and the government wants to reach these people; aiming to deliver education to remote, mountainous, rural areas where the economy, science, technology, education and culture are underdeveloped; the desire to reduce costs; providing training in the professional fields of personnel working in different institutions and pre-service

people constitute the reasons why China gives importance to distance education. (Harry, 2003; Moore & Kearsley, 1996).

Distance education in China is carried out in three different ways: 1- Distance education by correspondence letter 2- Radio and TV education 3- Self-study. By correspondence distance education activities are offered as a two-way service by a small number of colleges and mostly regular higher education institutions. Beijing Post and Communication Institute, the country's higher education institution, carries out distance education activities by correspondence in the country. Today, China Radio and TV University (RTVU), which is a mega university, continues its distance education through Radio and TV. Distance education through self-study is carried out part-time in the form of state exams in a certain time. This education is not an institutionalized education with full teaching, learning support and student management functions, but a system of examinations conducted by the goverment (Harry, 2003; TUENA, 1997).

In the People's Republic of China, important developments occurred in the distance education system in parallel with the technological developments that took place in 1979 and 1988. In 1988, a giant step was taken in establishing a modern large-scale distance education system, as Satellite TV offered a cost-effective method of communication. Thus, China has established a highly structured system for distance education. This system, as central and local has been established at five levels: the State Education Commission, the Provincial Education Commission, the Governor's Office of Education, and the District Education Office, (Moore & Kearsley, 1996).

At the first level, China Radio and Television University (CTVNC) was established and given under the responsibility of the State Education Commission (TUENA, 1997). This is a national central university as the name suggests. It consists of 28 regional Radio and Television Universities in the states to enable it to spread educational studies throughout the great country.

The system of these distance education universities work with three structural aspects :departments in the provinces, which are closely connected to the goverment administration, study centers in the districts, and local television classrooms. Currently, this distance education university has three kinds of the student groups. These groups consist of people who want to receive undergraduate education in full-time employment, secondary school graduates at the university, and those who quit their education before due to various reasons and restart to complete their education. With all these students, this university has a total of more than one million students (Peters, 2006). In this university, associate and undergraduate courses are offered in fields such as natural and human sciences, economics, health, engineering, linguistics, agriculture and finance. In addition, courses are offered in various fields (TUENA, 1997).

At the second level, the Provincial Radio and Television University (PRTVU) was established under the responsibility of the Provincial Education Commission. Education is given in medicine, nursing, food, foreign trade and English (TUENA, 1997; Moore & Kearsley, 1996).

At the third level, there are Branch Schools providing distance education under the responsibility of the District Education Office. These schools maintain education in the form of tests, exams, TV broadcasts and laboratory studies (TUENA, 1997).

At the fourth level, there are workstations under the responsibility of local governments. Workstations organize classes, enroll students, collect fees, distribute course materials, and schedule for teachers. Class units at the fifth level provide direct supervision and support educational programs (Moore & Kearsley, 1996). This system, which was established in five steps in China, supports a central planning and implementation of courses and programs, and ensures that the courses are implemented at a significant central and local level (Moore & Kearsley, 1996).

In China, which has a large population, the open university system is quite common and has an vital place in education. There are 6 open universities including China National Open University, Beijing Open University, Jiangsu Open University, Yunnan Open University, Guangdong Open University and Shanghai Open University (Altınpulluk, 2016). There are four different sources of funding for distance education in Chine. These include government funding, financing provided from various institutions, primarily business environment, funds provided by students themselves or their families, and other resources (Harry, 2003).

As a result, China has made significant efforts in distance education and has mega universities in the World. However, it is structurally different from the open universities in western countries in a few points. Education policy has a different function. Open universities are not conducted to help the disadvantaged people in terms of education as in other countries, but to ensure the development and modernization of the country to a large extent. Moreover, distance education courses are given during working hours. Teaching programs on television play a dominant role for anyone who bases their academic education on writing. Finally, group teaching is emphasized rather than individual learning as it is practiced in the western world (Peters, 2006).

Distance Education in India

After declaring its independence in 1947, India included distance education in its five-year development plans and over time, it has made significant progress in distance education. Although there has been a tremendous increase in the number of higher education institutions over time, higher education institutions that cannot keep up with

the increasing number of students have made the best use of distance education as a tool for continuing education.

Loka Siksha Sambad, a central university, started distance education with 1,112 students via correspondence at undergraduate level in 1962. Dr. D.S. under the chairmanship of Kothari, through correspondence, the Government of India aimed to provide higher education opportunities for those who are generally unable to attend colleges, receive regular education and attend classes regularly due to social, family and employment constraints. Thus, distance education has been accepted as a viable complementary mode (Peters, 2006).

In August 1982, within about two and a half months with the State Legislative Act, students started to pursue distance higher education through correspondence at thirty-four universities, led by Andhra Pradesh Open University. In addition to these developments, Indira Gandhi National Open University (IGNOU) was established on September 20th, 1985, by the help the leadership of academics and with the efforts of the Indian government (İşman, 2011; Peters, 2006). Later, this university simultaneously increased student enrollment in Distance Education institutions through correspondence. By 1998, institutes of fifty-eight major universities in India had established distance education departments which maintained teaching by correspondence and the other distance education units. and there are nine open universities in the country with a total enrollment of about 20 percent of students.Thus, the number of students enrolled in open universities in India approached one million and a tremendous increase was seen in distance education (Peters, 2006).

Today, Indira Gandhi National Open University (IGNOU) serves the educational goals of more than 3 million students in India and other countries with 21 education schools and 67 regional centers, approximately 2,667 student support centers and a network of 29 overseas partner institutions. The university offers approximately 228 certificate, diploma, undergraduate and doctoral programs with approximately 33,212 academic advisors in traditional higher education, professional organizations and industrial institutions as well as 810 faculty members and 574 academic staff in central and regional centers (IGNOU, 2014). The mission of the university (IGNOU) is to provide access to higher education for all segments of society, to offer high quality, innovative and need-based programs at different levels to all those who need higher education, to reach disadvantaged people by offering affordable programs all over the country, to encourage the formation of education standards offered through open and distance education in the country, to organize and to coordinate distance education activities and courses opened in various fields by other universities. The aim of universities is to reach all units of the society, to deliver continuous professional development training to all sectors of the economy, and to develop various communication tools, and to use the latest technology

in order to achieve these goals. This reflects the vision of IGNOU, which keeps its goals in focus (IGNOU, 2014).

Open universities in India follow a regional and centralized study system so that they can operate a massively industrialized system of education, design and develop materials, provide student support, and administer academic programs. These universities offer various certificate, diploma, undergraduate, graduate and doctoral level education and expands various programs for employment and vocational skills for both economic and national development purposes. These programs include the those dapartments such as management, computer education, surgery, nursing, library and information science, food and nutrition, mother and child health, tourism studies, water resource management, construction management, creative writing, rural development, child care and education, teacher training, journalism and mass communication, agriculture, applied electronics, horticulture. In India, students are provided with assignments, projects, practices, counseling, audio and video programs, library access, workshops and teleconferences as well as supported print training modular packages (Peters, 2006; TUENA, 1997).

Open chool was opened in 1979 in order to carry out education activities through distance education at high school level in India. This open high school has a special goal such as reaching students who are out of formal education with various reasons by expanding opportunities in education throughout the country (TUENA, 1997). One of its other important goals is to provide education opportunities for girls aged 6-14 and to ensure education that will provide career and individual development to adult women who have not received education in previous years. There is no age limit for the open school. In the open school, various courses are organized to meet the educational needs of different target groups. During the holiday, face-to-face education is offered as well as distance education, and exams are held in April and October (TUENA, 1997).

Distance Education in Australia

Education in Australia has constantly undergone change in recent years. These changes and developments have also greatly affected distance education. Australia has recently witnessed not only a general conceptual movement towards a student-centered service, but also more tangible developments to the point that institutions produce course materials by using the full range of available technologies very quickly (Harry, 2003). Distance education in Australia took place in three phases.

1st period: Distance education by correspondence mostly covers distance education studies where there is no direct interaction between the teacher and the student by mail. This period covers the years 1910-1970. The university has proposed distance education with correspondence in response to the demands of politically rural areas as distance education has more convenient and less costly access.

2nd period: It covers the period when multimedia and two-way communication tools are used to increase effective teaching and learning. In Australia, this period has been from the early 1970s to the mid-1980s.

3rd term: It covers the period when open, flexible and online learning, internet and digital technologies are used, there are student-teacher, student-student interaction, collaborative group work and flexibility is provided for students in terms of time. This period covers the period to the present from the mid-1980s (Qayyum & Zawacki-Richter, 2018).

Today, many schools and universities in Australia offer distance learning courses as part of their regular education activities. Generally, a two-way communication structure is used (Moore & Kearsley, 2006). Australia has 40 public universities, two international universities and one private university. In these universities, 1,410,133 students, of which 1,046,682 are in the country and 363,451 are abroad, are served through distance education (Australian Government Department of Education and Training, 2017).

Distance Education Centers have been established within the university in order to contribute to distance education in Australia. beyond the general changes in the university sector in 1991, the government paid special attention to distance and open education. Institutions have served distance education not only in relation to the standards of teaching resources and support available to off-campus students, but also in line with government-nominated access and equity goals. In the universities, Associate, undergraduate and postgraduate courses are offered. On the other hand, universities have done distance education for a certain fee to create their budgets (Harry, 2003).

In 1992, the Australian Open Learning Agency, a special education commission, was established. It was later renamed Australian Open Learning (OLA). The purpose of the Australian Open Learning system was initiated to meet the needs of the large number of students from different backgrounds, qualifications, motivations and capacities who could not complete their education in traditional ways. It was funded and supported by the Federal Government. This institution was not an open university awarding its own degree; however, it provided special preparation programs to students and helped them complete the credits that enabled them to graduate from education (Moore & Kearsley, 2006; Harry, 2003). Today, this not-for-profit consortium of seven public universities (Curtin, Griffith, Macquarie, Monash, RMIT University, Swinburne and the University of South Australia) has been renamed Australian Open Universities (OUA). There is no academic entry requirement for students. OUA, which consist of 1000 online units from 12 of Australia's leading universities, offers more than 156 associate, undergraduate and graduate programs in the arts, humanities, business, education, health, information technology, law, justice, science and engineering. Students pay a fee for 13 weeks of undergraduate study. Those wishing to complete a semester's study through a university

that offers face-to-face education pay half of the tuition fee. Working in cooperation with various universities, students are given the opportunity to take courses and graduate from this open university in order to complete their own missing credits (Qayyum, & Zawacki-Richter, 2018).

Australian universities are at the forefront of promoting the use of Open Education Resources (OER). Charles Sturt University, University of Tasmania, University of Technology, Australian Government Department of Education and Training (Student Information and Learning Branch) Higher Education Group have developed a national roadmap to support open education resource reuse and course material production policies. It has developed new strategies to promote innovative pedagogical models and to respect and empower students as co-producers in their lifelong learning, demonstrating the benefits of developing and using OER. In this context, Southern Queensland University (USQ) promoted the use of OER in open education programs by offering its own courses to the Open Education Consortium. In addition, international partnerships have been gained to share open education courses and distance education content globally in Australia. The reuse of these materials is permitted by other Australian and US universities, Australian TAFE Colleges and other providers. USQ also continues to contribute to distance education as the founding partner of the global Open Educational Resources universitas (OERU) (Qayyum, & Zawacki-Richter, 2018).

Many universities in Australia, notably the Australian National University, Monash University and Australian University, are making efforts to develop Massively Open Online Courses (MOOCs) that contribute to people's learning in many different ways. In parallel with these developments, other universities such as Queensland University of Technology, University of New South Wales and Swinburne University have added their MOOCs to their open universities. In addition to these developments, in June 1999, U3A Online Inc.13, the world's first virtual university of the third age, started to offer a variety of online courses and courses to develop basic computer skills for all older people and disabled younger people anywhere in the world, especially those who are geographically, physically or socially isolated. These online courses are especially suited to older members of the community who are isolated either geographically, or through physical or social circumstances (including carers). Also, universities are increasingly offering informal online courses. After the interactive courses given for a certain period of time, those who are successful in the online exams are given an Online Certificate (Qayyum, & Zawacki-Richter, 2018).

Universities in Australia have their own accreditation. In this context, all universities are given an autonomy to operate within the legal requirements regarding Australian Government funding. Since January 2012, the Higher Education Quality and Standards Agency (TEQSA) has operated as the national quality assurance agency for Australia's

higher education sector, has taken on the role of the Australian University Quality Agency (AUQA) which is an independent, not-for-profit national agency which was established to promote, audits, and reports on quality assurance in Australian higher education. TEQSA registers institutions and accredited courses using the Higher Education Standards Framework as a benchmark (Education System Australia, 2018).

There are two types of schools in Australia that offer distance education at primary and secondary level. The first of these is Open and Distance Education Schools (School of Isolated and Distance Education) and the other is Schools of the Air (SIDE, 2020)

School of Isolated and Distance Education are distance education and online learning schools created for students who need additional flexibility at primary and secondary level and cannot attend school in a traditional classroom environment. The School of Isolated and Distance Education (SIDE) is the main centre for Kindergarten to Year 12 distance education and online learning within the Western Australian Department of Education. It began operations as the Correspondence School in 1918. The School of Isolated and Distance Education (SIDE) are distance education and online learning schools created for students who need additional flexibility at primary and secondary level and cannot attend school in a traditional classroom environment. These schools are generally attended by students who cannot attend full-time schools due to geographical reasons, travel nationally or internationally with their family in the long term, who enroll in a full-time school but cannot take the courses they want, who involve with elite performance including sport, theatre and music, and who cannot attend regular school due to severe health conditions. Courses are offered online with practical materials delivered to the home. These schools are leaders in the use of technology to independently deliver a high standard of education. These schools use digital technologies to deliver online education programs. The teaching takes place in two ways: The first of this teaching takes place with synchronous, real-time communication over the WebEx web conferencing platform. The second is asynchronous, with 7/24 access. Moodle is also used to present course program materials and facilitate online student and teacher collaboration. Lessons are presented in an atractive way to the elementary and high school children (SIDE, 2020).

School of the Air is a generic term for correspondence schools catering for the primary and early secondary education of children in remote and outback Australia where some or all classes were historically conducted by radio, although this is now given by telephone and internet technology. In these areas, the school-age population is too small for a conventional school to be viable. In these areas, there are a total of five schools whose school-age population is too small to accommodate a traditional school. These schools are located in Carnarvon, Kalgoorlie, Derby, Meekatharra and Port Hedland.

Schools of the Air provide comprehensive education to families with children living

in in remote areas get an education. Each of the five schools serves large areas of Western Australia. Online and offline courses are offered alongside radio and television broadcasting. A SATWEB installation (computer, pc units, printer/scanner/copier, satellite dish and installation etc.) and CD ROM based software, math equipment, early childhood education resources, library and sports equipment are delivered to each registered family, and credit support for these equipment is provided (SIDE, 2020).

Rising Trends in Open and Distance Education Today

Although distance education may seem like a new idea to most educators today, its roots go back more than a century. Despite the recent growth and change in distance education, it continues to shape the future with its deep-rooted traditions (Simonson et al., 2008). Moore and Kearsley (1996) examined the development of distance education in five main phases, by taking into account the use of technological tools. These phases are 1- Distance education by correspondence 2- Radio and television broadcasting; 3-Open universities; 4-Teleconferences; 5- Internet / Web. The development process of distance education is given in Figure 2.

The Development Process Of Distance Education

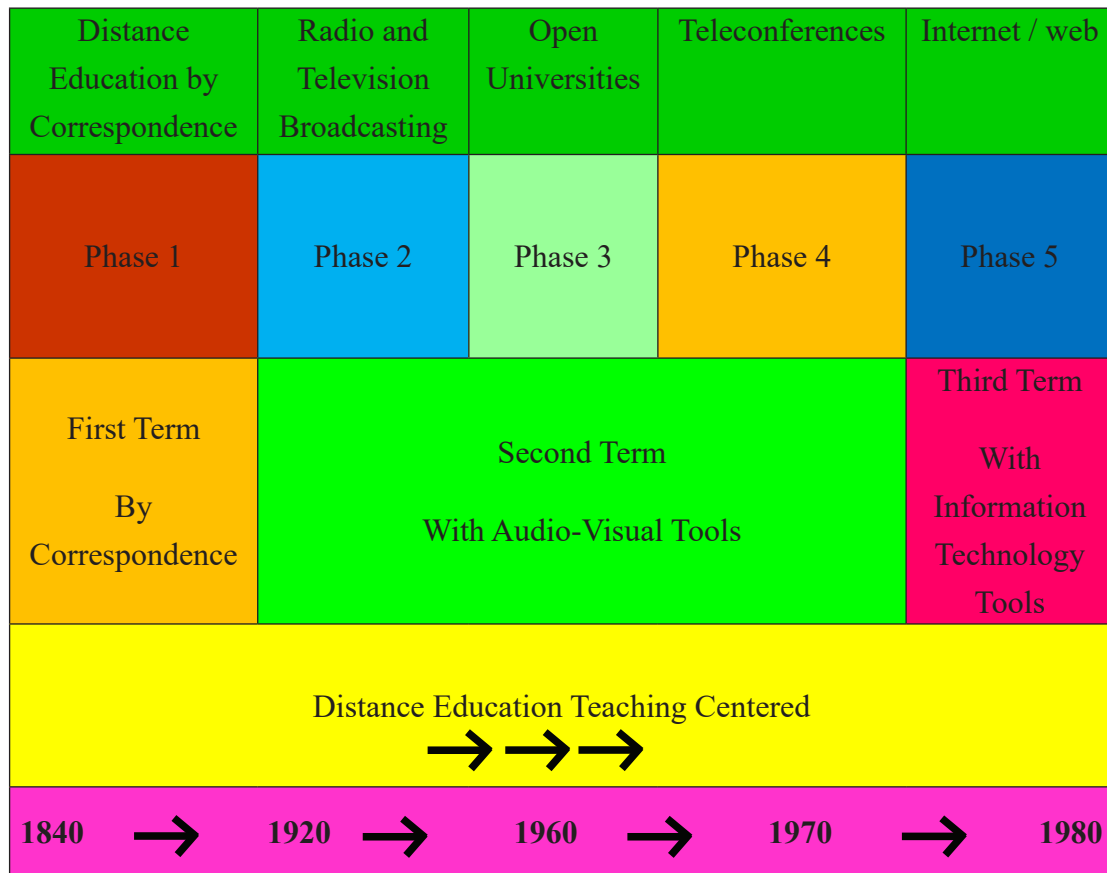| Distance Education by Correspondence	Radio and Television Broadcasting	Open Universities	Teleconferences	Internet / web
Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
First Term By Correspondence	Second Term With Audio-Visual Tools			Third Term With Information Technology Tools
Distance Education Teaching Centered → → →				
1840 →	1920 →	1960 →	1970 →	1980

Figure 2. The Development Process of Distance Education (Moore & Kearsley,1996).

It constitutes the first phase of distance education by letter between the years 1840-

1920. In this phase, distance education was widely used via newspaper and letter. During these years, education continued by correspondence. In the second phase, which covered the 1920s and 1980s, countries expanded distance education through radio and television channels. After 1960, which is the third phase, countries started to continue distance education through the open university they established. Pharese 4 includes the years between 1970 and 1980. In this phase, a two-way distance education system was implemented with the teleconference system.

Audio-visual tools were widely used in the second, third and fourth phases of distance education. The last phase is the Internet phase, in which computer technologies are widely used and effectively used since 1980.

At the end of the twentieth century, distance education began to take an important place with international economic, political and related ideological changes. In parallel with these changes, significant developments have been recorded in the field of technology. Thus, these changes in turn led to the creation of a new set of regional and international policies for education (Harry, 2003). In particular, developments related to information and communication technologies have significantly affected distance education (Aydın, 2002). Distance learning has been widely used in both formal education and distance education with various applications of computer technologies highly created in the education systems of countries. Thus, new trends began to emerge in open and distance learning (Özbek, 2014). Trends in the use of these distance education tools that shape education are described in the Horizon Report. Horizon Report is a comprehensive project by experts from various countries, established in 2002 in collaboration with the New Media Consortium (NMC) and the EDUCAUSE Learning Initiative (EDUCAUSE Learning Initiative-ELI). The aim of this project is, in education, to describe and explain important developments in technology that are likely to have a major impact on a global scale in the next five years. The NMC Horizon Report highlights six emerging technologies that are likely to be used and implemented over the next five years in focus sectors such as primary, secondary (K-12) and higher education, museums and libraries globally. It covers the discussion of the main trends and efforts that will affect the current education system in the same period (Johnson, et al., 2016). In this context, it can be said that these reports, which deal with the developments and applications in educational technology, reflect the main trends in open and distance education. The main trends in the Horizon Report between 2005 and 2020 are given in the table below.

Short, Medium and Long Term Trends Described in Horizon Report		
Year	Short-Term Trends One Year or Less	Mid-Term Trends Two to Three Years	Long-Term Trends Four to Five Years

2005	Extended Learning Ubiquitous Wireless	Intelligent Searching Educational Gaming	Social Networks & Knowledge Webs Context-Aware Computing/ Augmented Reality
2006	Social Computing Personal Broadcasting	The Phones in Their Pockets Educational Gaming	Augmented Reality and Enhanced Visualization Context-Aware Environments and Devices
2007	User-Created Content Social Networking	Mobile Phones Virtual Worlds	The New Scholarship and Emerging Forms of Publication Massively Multiplayer Educational Gaming
2008	Grassroots Video Collaboration Webs	Mobile Broadband. Data Mashups	Collective Intelligence Social Operating Systems
2009	Mobile Phones Cloud Computing	Geo-Everything. The Personel Web	Semantic-Aware Applications Smart Objects
2010	Mobile Computing Open Content	Elektronic Books Simple Augmented Reality	Gesture-Based Computing Visual Data Analysis
2011	Electronic Books Mobile Phones	Augmented Reality Game-Based Learning	Gesture-Based Computing Learning Analytics
2012	Mobile Apps Tablet Computing	Game-Based Learning Learning Analytics	Gesture-Based Computing Internet of Things
2013	Massively Open Online Courses Tablet Computing	Games and Gamification Learning Analytics	3D Printing Wearable Technology
2014	Flipped Classroom Learning Analytics	3D Printing Games and Gamification	Quantified Self Virtual Assistants
2015	Bring Your Own Device (BYOD) Flipped Classroom	Makerspaces Wearable Technology	Adaptive Learning Technologies The Internet of Things

2016	Bring Your Own Device (BYOD) Learning Analytics and Adaptive Learning	Augmented and Virtual Reality Makerspaces	Affective Computing Robotics
2017	Adaptive Learning Technologies Mobile Learning	The Internet of Things Yeni Nesil Next Generation (LMA)	Artificial Intellihence Natural User Interfaces
2018	Analytics Technologies Makerspaces	Adaptive Learning Technologies Artificial Intelligence	Mixed Reality Robotics
2019	Mobile Learning Analytics Technologies	Mixed Reality Artificial Intelligence	Blockchain Virtual Assistants
*2020	• Adaptive Learning Technologies • AI/Machine Learning Education Applications • Analytics for Student Success • Elevation of Instructional Design, • Learning Engineering, and UX Design • Open Educational Resources • Artificial Intelligence: Technology Implications • Next Generation Digital Learning Environment (NGDLE • XR (AR, VR, MR, Haptic) Technologies		

*Short, medium and long-term targets have not been specified in 2020.

Table 4. Key short, medium and long-term Trends between 2005 and 2020 in Horizon Report Today (NMC, 2005; NMC, 2006; NMC, 2007; NMC, 2008; Johnson & Smith, 2009; Johnson et al., 2010; Johnson et al., 2011; Johnson et al., 2012; Johnson et al., 2013; Johnson et al., 2014; Johnson et al., 2015; Johnson et al., 2016; Becker et al., 2017; Becker et al., 2018, Alexander et al., 2019, Brown et al., 2020).

Distance education has taken new forms in parallel with the developments in technology, and the adventure that started with letter teaching continues with advanced information tools. However; the use of computers in education has been a turning point for distance education. Learning theories and approaches that have guided education for many years have transformed with computer technology. With the widespread use of computer and internet technologies at a global level, electronic learning has begun to be used effectively in all areas of education.   Today, e-learning tools are easily used by students, teachers and adults (Firat & Yurdagül, 2013). As can be seen from Table 4, it has been observed that new trends have emerged in the use of information tools in educational environments, both in formal education and in the use of individuals for educational purposes throughout their lives. In this context, the structuring of the distance education

system, the characteristics of the target audience how the learner, the teacher and the content will interact with each other by taking into the consider communication opportunities in line with the learning objectives, how the learners and the instructors will be brought together in terms of time and space has been a matter of curiosity for educators (Aslantaş, 2014).

In parallel with these technological developments, it is seen that new learning trends in distance education are on the rise. Accordingly, it is known that educators use one or more methods and learning environments effectively to reach the target audience. In education environment, the rising learning trends stated in the Horizon Report between 2005 and 2020 are given in Table 5 under the main headings.

The Rising Learning Trends in Distance Education Today
1. Ubiquitous learning
2. Mobile Learning
3. Blended Learning
4. Adaptive learning
5. Flipped Classroom
6. Game-Based learning
7. Micro Learning
8. Context Aware Learning
9. Seamless learning
10. Digital Literacy
11. Massive Open Online Courses
12 . Learning Analytics
13. Gesture Based Interaction
14. Personal Learning Environments
15. Virtual Learning Environments

Table 5. The Rising Learning Trends in Distance Education Today (NMC, 2005; NMC, 2006; NMC, 2007; NMC, 2008; Johnson & Smith, 2009; Johnson et al., 2010; Johnson et al., 2011; Johnson et al., 2012; Johnson et al., 2013; Johnson et al., 2014; Johnson et al., 2015; Johnson et al., 2016; Becker et al., 2017; Becker et al., 2018, Alexander et al., 2019, Brown et al., 2020).

Acknowledgements or Notes

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About the Authors

İsmail Coşkun is a PhD student from Eskişehir Osmangazi University, Turkey. He is the assistant principal of the school in the Ministry of National Education in Eskisehir, Turkey. His research interests include evaluation of teachers' in-service training programs, teacher training, distance education. icoskun26@gmail.com

Cavide Demirci is a professor at the Department of Education Sciences in Faculty of Education in Eskisehir Osmangazi University, Turkey. She has studies on active learning strategies, active learning practices in the classroom, teacher training. cdemirci@ogu. edu.tr

To Cite This Chapter:

Use of Digital Stories in Education in the 21st Century

Imren Calik
University of Eskisehir Osmangazi

Munise Seckin-Kapucu
University of Eskisehir Osmangazi

Introduction

Rapid developments in technology have led to change and transformation in education as occurred in many areas. The integration of the new technologies changing and developing with the necessities of the age into the learning and teaching processes has become inevitable. The methods and techniques, tools, and materials used in education have undergone serious changes from past to present. One of them is storytelling. Information transfer through storytelling was done through written sources in the past; today, it is done through digital storytelling with developing technologies.

In recent years, digital technologies have become a necessity in education, as in other fields. The use of new methods and techniques in education is gaining importance day by day to increase learning effectiveness. One of these methods is digital stories. Regarding the studies on digital storytelling, this approach was considered a powerful and effective tool in educational environments (Clarke & Adam, 2011).

Stories are a natural and effective method that bridges people and experiences from the past to the present. Digital storytelling, which is gaining a new form with the developing technology, is a natural and effective way to transfer knowledge, emotion, thought, and experience. In addition, digital stories, which appeal to both visual and auditory senses, are highly memorable and interesting and are a preferred tool in many fields, including education. The reason for preferring digital storytelling in education is that it is a suitable learning-teaching tool for almost all ages and grades (Robin, 2006).

21st Century Skills and Digital Storytelling

In the 21st century we live in, the importance of qualified human resources increases day by day. Technological and scientific developments, which are constantly changing, play a major role here. Leading countries in technology and science have reformed their education systems to raise qualified individuals who can adapt to the age's requirements. Changes were made in education following the expectations from 21st-century students. 21st-century skills refer to skills and competencies that contribute to individuals becoming good citizens and qualified workers concerning the needs of social and economic development models (Ananiadou & Claro, 2009). The digital storytelling process is seen

as an educational technology that can meet most of the skills students should possess in the 21st century (Jakes, 2006; Jakes & Brennan, 2005a; Robin, 2008; Niemi et al., 2014). Digital storytelling helps students develop multitasking skills such as 21st-century skills and contributes to education by allowing students to acquire these skills (Foley, 2013).

Regarding about 21st-century skills, today's individuals are expected to work in cooperation, be information, media, and technology literate, think independently, creatively, and be critical, solve problems, produce and learn how to learn. Using cutting-edge technology tools to be creative, taking risks, and communicating make digital storytelling a natural process reflecting 21st-century learning (Jakes, 2006). In addition, the digital storytelling process enables individuals to develop 21st-century skills such as communication and technology use.

Digital storytelling meets 21st-century skills, including digital literacy, global literacy, technology literacy, visual literacy, information literacy, creative thinking, effective communication, and high productivity (Jakes, 2006; Robin, 2008).

Regarding 21st-century competencies, computer skills, information technology, media, and information literacy skills, which should be present in the information age, are the skills we need to survive in a global society (Komalasari, 2021). In the digital age, the methods of accessing and using information have also changed. With the increasing importance of technology and the widespread application of digitalization, innovation and change occurred in education. In this age, also called the digital age, digital reform in education occurs with digital transformation and innovations.

Digitality and technology are included within the scope of 21st-century skills determined by different institutions and organizations. The 21st Century Learning Framework prepared in 2009 by The Partnership for 21st-Century Skills-P21 expressed them as Information, Media and Technology Skills (Information literacy, Media literacy, Technology literacy); EnGauge as Digital Age Literacy (Basic, scientific, economic, and technology literacy, Visual and Information literacy, Multicultural literacy, and global awareness); ATCS as Working Tools (Information literacy, Information & Communication Technology (ICT) literacy); ISTE/ NETS as Technology Operations and Concepts (understanding technology concepts, systems, and processes) and Digital Citizenship (understanding technology-related societal and cultural issues); EU as Digital Skills, Cultural Awareness, and Expression; OECD as Interactive Use of Tools (interactive use of technology); and North Central Regional Education Laboratory (NCREL) as Digital Age Literacy (basic, scientific, economic and technological literacy, visual and information literacy, multicultural literacy and global awareness). (Partnership for 21st-century skills [P21], 2006; EnGauge, 2003; Assessment and Teaching of 21st-Century Skills [ATCS], 2007; National Educational Technology Standards [NETS or ISTE], 2007; ''Technological

Literacy Framework for the National Assessment of Educational Progress [NAEP]", Organization for Economic Cooperation and Development [OECD], 2005; European Union [EU], 2002).

The skills such as deciding when and how to use technology and choosing the appropriate technology for a certain job come to mind with the technology developed within the scope of 21st-century skills. Digital storytelling is one of the approaches that can meet the needs of the age in education, make learning effective, and enrich learning environments with technological tools and software.

What is Digital Story?

Stories have been a powerful communication tool with their prehistoric, intercultural and international use. Storytelling has undergone significant changes from the past to the present, allowing the transfer of the events that people have experienced or designed in various environments and ways. Paintings drawn on cave walls from the Paleolithic age, that is, 40,000 years ago, have conveyed important information about the lifestyle and culture of people in the past, which can be considered the beginning of storytelling. Storytelling can also be described as expressing opinions, revealing and presenting emotions to motivate others, conveying information, and sharing experiences (McDrury & Alterio, 2003).

The stories, which continued their existence mostly with oral literature tradition, later passed into written form. With the introduction of digital technologies into our lives, storytelling, which dates back centuries, has changed its form and content and has been transferred into the digital environment by blending with advanced technological possibilities. With the possibilities offered by digital technologies, telling and listening to stories has become easier and more accessible (Baki, 2015). Along with this, the concept of digital stories has emerged.

There is no common definition of digital storytelling in the related literature, and it is defined in different ways. Some of them are: Creating stories using digital tools, sharing stories and information through the media (Armstrong, 2003); The technological product that emerges with the integration of storytelling and technology, and the combination of the written story with digital elements such as sound, visuals, motion, etc. (Kulla-Abbott, 2006); Associating multimedia elements such as text, graphics, sound, video, and music with each other (Robin, 2006); Integrating texts, pictures, videos, and sound into an aesthetic presentation of the multimedia story via computer (Chung, 2006); Combining written, verbal, visual and animated symbols into 3-5 minute videos (Tatum, 2009). Based on the definitions above, we can define digital storytelling as the process of presenting traditional storytelling in a modern form by enriching it with digital content such as pictures, music, sound, and video.

Although digital storytelling is based on the concepts of "story" and "telling" (Hartley & McWilliam, 2009), digital storytelling is supported by the text created with the integration of Web 2.0 tools such as script, slideshow, audio, all kinds of visuals and short videos (Daskolia et al., 2015). Qiongli summarizes the main features that distinguish digital storytelling from other forms of storytelling as below (2009, pp. 230-231).

- Story-oriented: The core of digital storytelling is not technology but the story itself. The priority of digital storytelling is the story first, and then digitalization.

- Disciplined: Digital storytelling is a disciplined approach. It has a practical framework that clarifies the possibilities and controls the process's form, quality, and efficiency.

- Authentic: "The emotions that stories bring come directly from people's hearts." In digital storytelling, the stories are original as they are conveyed through the storyteller's fiction, feelings, and thoughts.

- Multimedia: Digital storytelling results with integrated multimedia in which sound, music, pictures, and videos are combined.

- Simple technology: Basic tools of digital storytelling are computers and microphones. Since the technological knowledge requirements are simple, it can be easily created by anyone.

- Found materials: A digital story can be created using pre-existing materials such as family albums, pictures, and videos; in short, it has the advantage of getting quick results with minimal preparation.

- Collaborative creativity: Joe Lambert believes that storytelling is a collaborative art. The concepts of sharing and inspiring through collaborative creativity are present in the digital story creation process.

History of Digital Storytelling

Digital storytelling began in the early 90s with Next Exit, an interactive theatrical performance, multimedia autobiography designed and performed by Dana Atchley and Joe Lambert. In this stage show, Dana Atchley understood the power of stories when the audience started to share their own stories saying, "Yes, I have such a story to tell" (Simsek et al., 2018). Dana Atchley and Joe Lambert discovered that people with little or no multimedia experience could create powerful personal stories using new digital media technology. The starting point of digital storytelling, which is still practiced today, is a series of workshops they started to popularize digital storytelling practice.

In 1994, Joe and Dana founded the San Francisco Digital Media Center with Nina Mullen. Over the next few years, the group developed a curriculum that formed the basis of a community workshop called "Digital storytelling." They have developed a unique computer education and arts program around the Digital Storytelling Workshop. After the San Francisco Digital Media Center moved to Berkeley in 1998, it started to use the name Center for Digital Storytelling. Since 2015 the organization continues its activities under the name of StoryCenter.

Types of Digital Storytelling

Digital storytelling works have been done on personal narratives. However, different types have emerged as the usage area has diversified and shaped by what individuals want to share. There are different classifications in the literature. Garrety (2008) classifies digital storytelling into five categories: traditional digital stories, instructive digital stories, project-based digital stories, social justice & culture-themed digital stories, and digital stories that reflect the person. Gregori-Signes and Pennock-Speck (2012) divide it into social digital stories and digital stories made in education. Robin (2006), on the other hand, grouped digital stories under three headings: personal narratives, stories addressing historical themes and events, and informative or instructive stories. In this study, the titles divided into three main groups by Robin (2006) are explained below.

Personal narratives: These are the stories that a person tells about their experiences, daily life events, or feelings through imagination and creativity. It is the most common type of digital storytelling. Personal narratives are important in conveying different events, cultures, and values from the narrator to the listener.

Stories addressing historical events: It transfers historical content or subjects from the past through digital media by reinterpreting them with individual differences. It can be used in teaching values such as independence, respect for national and cultural values, peace, freedom, and patriotism.

Informative or instructive stories: It is the type of digital storytelling in which educational content on various subjects from mathematics, science, art, technology to medical education is presented by a digital narrative.

Elements of the Digital Story

The Center for Digital Storytelling helped create the digital storytelling movement by starting a new trend in storytelling. They provided training and assistance to individuals in creating and sharing their narratives. The Center for Digital Storytelling (CDS) has also developed the Seven Elements of Digital storytelling, often cited as a useful starting point for working on digital stories (Robin, 2008, p. 223). These seven elements are

point of view, a dramatic question, emotional content, the gift of your voice, the power of the soundtrack, economy, pacing. These seven elements are briefly shown in Figure 1.
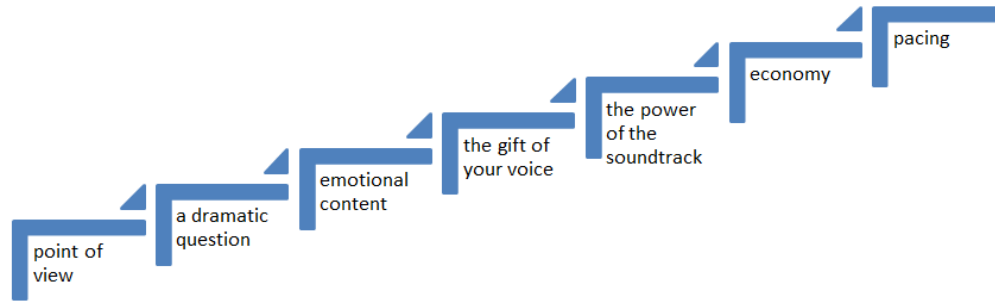

Figure 1. The Seven Elements of Digital Storytelling

These seven elements come into play in two different stages during the creation of the digital story. According to Bull and Kajder (2004), the elements of point of view, a dramatic question, emotional content, and economy are present in the *writing and planning stages of digital stories*; whereas the power of the soundtrack, the gift of your voice, and pacing elements *are included in the creation stage of digital stories*. In the first stage, the scenario is prepared and reviewed. In other words, it is decided what is wanted to be told in the story and how the story should be seen. After the scenario is completed, a digital story is created using multimedia tools at the creating stage.

<div align="center">

Digital Story Creation Process

</div>

The digital story creation process achieves its purpose and goal with a well-planned story. Researchers working in this field have identified different stages of the digital story creation process. Lambert (2010) outlined the process as follows: determining the point of view, determining the emotions, determining the moment, seeing the story, listening to the story, combining the story, and sharing the story. Robin (2014) outlined it in seven stages; writing a story scenario, creating the story flowchart, researching the visuals, vocalizing the story, preparing the digital story, evaluating the digital story, and publishing the digital story. Barrett (2009) grouped the stages in the digital story creation process under five headings: writing story text, sound recording and editing, collecting visuals, creating and publishing stories. Jakes and Brennan (2005b) grouped the stages in the digital story creation process under six headings: writing the story, creating the script of the story, creating the storyboard, researching the multimedia elements to be used, creating the digital story, publishing or sharing the digital story.

According to Tolisano (2008), there are three stages in the digital story creation process; The first stage is the preparation stage, which includes writing the story script and selecting multimedia elements. The second stage is the digital story creation stage: a

digital story is created by combining computer programs or web-based applications with other elements such as pictures, voiceovers, and music. In the third stage, the digital story takes its final shape and is uploaded to the internet or computer. Stage 1 storyline: writing, storyboarding, scripting. Stage 2 selecting and creating media: text, audio, pictures, video. Stage 3 project: importing, editing, and exporting media. Robin and McNeil (2012) described the process of creating digital stories in seven stages. These are: Writing the story script, Creating the story flowchart, Researching the pictures, Narrating the story, Creating the digital story, Evaluating the digital story, Publishing the digital story.

Regarding the digital story creation processes specified by the researchers, the story's script, that is, the scenario, is created first in all of them. Visuals that will help tell the story are identified. In the next step, the flow chart of the story is created. The identified visuals are put in this scheme. After the completion of the planning stage, the appropriate program for creating a digital story is selected. The digital story takes its final shape in the next stage by combining media elements such as pictures, sound, music, and text. This process ends with the publication of the digital story.

<div align="center"><strong style="color:red">Digital Storytelling Tools</div>

Robin (2008), on the other hand, stated in his study that the tools and software required for digital storytelling are cheap and accessible today and that the use of digital storytelling in the teaching environment converges (Figure 2).

Figure 2. The Convergence of Digital Storytelling in Education (Robin, 2008, s. 223).

Various tools and software are required to combine the elements such as text, picture, music, and sound, which are added while creating the digital story supported by technological tools. First of all, the technological infrastructure should be created. Afterward, it is necessary to have the competence to use technological tools. Some of the tools that can be used in the creation of a digital story are as follows (Garrety, 2008; Robin, 2006):

1. Basic tools: Computer (desktop, laptop, or tablet), smartphone, etc.

2. Voice recorders: Microphone, mp3 or mp4 player, mobile phone, etc.

3. Imaging tools: Video camera, camera, scanner, mobile phone, etc.

4. Listening tools: Headphones, speakers, etc.

5. Storage tools: External hard disk, flash memory, CD/DVD, etc.

6. Projection tools: Projector, smart board, computer, etc.

While creating the digital story, one should plan and prepare the tools such as computers, cameras, microphones, and necessary software (Robin, 2006). There is numerous software developed for the process of creating the digital story using basic tools. They can be grouped under three headings (Robin & Mcneil, 2012; Brenner, 2014; Bull & Kajder, 2005; Robin, 2006). These software programs are given in Table 1.

Table 1. Software Programs Used in Creating Digital Story

Software Programs Used on Desktop and Laptop Computers	Software Programs Used in Smartphones and Tablets	Software Programs Used in Web Environment (Web 2.0)
Microsoft Photo Story 3	StoryKit	Animoto
Microsoft Live Movie Maker	Storyrobe	Wevideo
Microsoft PowerPoint	iTalk	Creaza
Imovie	Fotobabble	StoryBird
Adobe Flash	iMovie for iPad	Toondoo
Scratch	ReelDirector	Storyjumper
Adobe After Effects	8mm HD for iPad	Slide.ly
Premiere Elements	Drawing cartoons	Powtoon
		Voicethread
		GoAnimate

Several tools and software program options are available in the creating, designing, and publishing adventure of digital story-making. Items such as text, photos, music, and video for digital storytelling can be finalized and shared through the tools and software listed above. Regarding the studies, the preferred software programs are observed to differ.

Simple technologies such as Microsoft Word and PowerPoint can be used in creating a digital story; on the other hand, a very effective program with a user-friendly interface, such as Photo Story 3, can also be preferred (Gabel, 2011; Robin, 2006). Studies have shown that the Animoto program came to the fore (Gabel, 2011; Sheneman, 2010). The programs called Audacity (Brenner, 2014; Gregori-Signes, 2008) and Voicethread (Brenner, 2014; Reinders, 2011), Garageband (Brenner, 2014) are preferred for adding audio and video in creating digital stories. In addition, Photoshop Elements, Microsoft Picture It, Picasa, and Microsoft AutoCollage (Kajder et al., 2005; Robin & McNeil, 2012) are used for editing pictures and photos.

The Use of Digital Storytelling in Education

The storytelling technique, which started after seeing the effect of traditional storytelling on learners, has changed and gained a new aspect with the digital age. Digital storytelling, which added a new dimension to the reform movements in education with the developing technology, is becoming an important part of teaching and learning. Educational institutions have investigated digital storytelling applications in the last few years (Smeda et al., 2010). Digital storytelling is an innovative approach that combines creativity and technology, offering the opportunity to integrate student-centered, interactive teaching and learning into technology-rich environments (Smeda et al., 2010). Digital storytelling is a method that helps to assimilate and structure the information by connecting it to the learned knowledge (Garrety, 2008).

Considering that our age is the age of technology and the dependency of the new generation on technology, digital storytelling is an alternative method to be used because it possesses the digital content that will attract the attention of learners and meet their interests and needs. In order to communicate with the new generation, teachers first need a change in the methodology and then develop new content and way of thinking (Prensky, 2001).

Robin (2006) discussed the digital stories used in education under two headings: "digital stories as an effective teaching tool for teachers and digital stories as an effective learning tool for students." In this context, digital stories prepared by teachers with rich multimedia content can increase students' interest, attract attention, and let them discover new ideas. They can also promote lessons, facilitate discussion, and make abstract or conceptual topics more understandable. Regarding the creation of digital stories by students, seven elements of digital storytelling should be introduced first. Then, some homework can be assigned to encourage students to research. They will learn to use resources such as the internet and the library to search the content in this process. They will create their own stories using their creativity by analyzing and synthesizing. They can organize their ideas while creating a narrative in a digital story. They can improve questioning,

self-expression, and communication skills; it can help them present their ideas and knowledge to the audience in a personal and meaningful way. These developments will allow the students to share their stories with their peers by publishing their digital stories on the web, contributing to their emotional intelligence and social learning by criticizing and commenting on them. They will gain a very important experience by working as a group. As can be understood from the explanations above, digital storytelling allows both teachers and students to gain new knowledge and skills.

Related Studies

There are many studies in the literature addressing different aspects of digital storytelling. Digital stories have a wide range of uses, including history, mathematics, literature, science education, teacher education, creative writing and thinking, health education, social and cultural studies, language teaching, writing skills, and memory (Campbell, 2012; Chuang et al., 2013; Hung et al., 2012; Kuo et al., 2012; McLellan & Wyatt, 2006; Miller, 2010; Opperman, 2008; Reinders, 2011; Ricci & Beal 2002; Robin, 2008; Titus, 2012; Yang & Wu, 2012; Xu et al., 2011).

Many studies in education discuss the use of digital stories for teacher education at different levels, for all age groups belonging to preschool, primary, and secondary education and its benefits for learning (Foley, 2013; Gyabak & Godina 2011; Heo 2009; Kearney 2011; Nguyen, 2011; Verdugo & Belmonte, 2007; Yang & Wu, 2012). In addition, it has been emphasized in the literature that it contributes to students' academic success (Daigle, 2008; Dogan, 2012; Wu & Yang, 2008), attitude (Butler, 2007; Gakhar, 2007; Norman, 2011), motivation (Barrett, 2006; Liu et al., 2018; Wu & Yang, 2008), the development of literacy skills (Banaszewski, 2005; Tatum, 2009; Xu & Ahn, 2010). by affecting them positively.

Studies show that digital story development contributes to the development of 21st-century skills, including critical thinking and problem-solving (Chen & Chuang, 2020; McLellan & Wyatt, 2006; Yang & Wu, 2012), reflective thinking (Kim & Silver, 2016), communication (Al-Amri, 2020), creative thinking (Anderson et al., 2018; Wu-Yang, 2008) and creativity and critical thinking (Anggeraini, 2020; Ohler, 2008; Tabieh et al., 2021). They can make a significant contribution to the development of students' higher-order thinking.

Conclusion

The rapid progress in technology has led to various changes and transformations in education as well as in different fields. This change and transformation have also affected the learning and teaching processes. As technology advances, using digital technologies in education has become necessary, revealing the need for different methods and

techniques. Digital storytelling is one of the methods that enable the transfer of technology to educational settings. Many researchers have emphasized that digital storytelling is a powerful and effective tool that enriches educational settings. Digital storytelling is also seen as an educational technology that can meet most of the skills that students should possess in the 21st-century. Digitality and technology are the common skills included in the scope of 21st-century skills determined by different institutions and organizations. Studies have also shown that using digital stories in education positively affects many variables such as students' imagination and creativity, academic achievement, motivation, and attitudes towards the course. The digital story creation process consists of various stages - writing the story, creating the story script, creating the storyboard, researching the multimedia elements to be used, creating the digital story, publishing or sharing the digital story (Jakes & Brennan, 2005b). Several tools, including basic tools, sound recorders, video tools, listening tools, storage tools, and shows, are used in this process. In the 21st century, digital storytelling emerges as an effective tool for both teachers and students to gain new knowledge and skills.

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About the Authors

Imren Calik received her master's degree from Eskişehir Osmangazi University in Eskisehir, Turkey. Her research interests include design-based science education and the use of digital stories in science education. Email: imren3225@hotmail.com

Munise Seckin Kapucu is an associate professor of Mathematics and Science Education at Eskisehir Osmangazi University in Eskisehir, Turkey. She has studies on science and technology program, teaching the nature of science, and the use of different technologies in science courses. Email: muniseseckin@hotmail.com

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SECTION 4
MATHEMATICS EDUCATION

Interventions to Address Mathematics Anxiety: An Overview and Recommendations

Dominic Petronzi
University of Derby

Thomas E Hunt
University of Derby

David Sheffield
University of Derby

Introduction

Mathematics anxiety (MA) can be described as tense and anxious feelings that impede the ability to manipulate numbers and solve mathematical problems in academic and ordinary life situations (Richardson & Suinn, 1972). Despite normal performance in most thinking and reasoning tasks, mathematics (maths) anxious individuals demonstrate poor attainment when solving maths problems (Ashcraft & Moore, 2009; Maloney & Beilock, 2012) as MA interferes with the cognitive processes required for successful mathematical problem solving. Recent work in this area has identified a neural threat response to maths stimuli when high maths anxious individuals are simply presented with a maths problem (Pizzie & Kraemer, 2017) or merely numbers (Batashvili et al., 2020). As an emotional rather than intellectual problem, MA places the individual in a cognitively passive state in which they experience panic, depression, helplessness, nervousness and fearfulness (Luo et al., 2009) and is a particular issue for those whose ability is already poor (Witt, 2012).

Carey et al. (2016) provides a useful discussion of the relationship between MA and performance, comparing a deficit theory and the debilitating anxiety model. The deficit theory argues that maths performance deficits, for example on maths tests, generate mild to extreme anxiety, which may be generalised in other situations. In contrast the debilitating anxiety model suggests that anxiety, particularly maths anxiety, reduces maths performance by affecting cognitive and emotional processes. In support of the deficit theory, there is longitudinal evidence to suggest that early poor maths performance can lead to the development of MA (Ma & Xu, 2004). There is also evidence of immediate effects of MA on performance, supporting the debilitating anxiety model. For example, time pressure detrimentally impacts performance among high maths anxious adults (Hunt & Sandhu, 2017) and the removal of time pressure lessens the impact of MA on performance (Faust et al., 1996). Furthermore, self-reported MA appears to be directly related to children's physiological reactivity to maths problems that increase in difficulty (Hunt et al., 2017). Moreover, there is evidence to suggest that physiological reactivity to mathematical problem solving is greater when individuals appraise the task

as threatening (Maier et al., 2003). These findings indicate that MA may lead to an affective drop in performance (Ashcraft & Moore, 2009) based on the argument that MA consumes essential working memory resources required for effective mathematical problem solving (Ashcraft & Krause, 2007). According to Carey and colleagues (2016) mixed evidence for the deficit and debilitating anxiety models might point towards a reciprocal relationship between MA and performance. That is, early poor performance may trigger the onset of MA, which in turn leads to poor performance, resulting in a vicious cycle.

Here we draw together empirical evidence from attempts to reduce MA, synthesising the literature and capturing a wide range of studies. Whilst a fully systematic approach has not been taken, the review considers work reported in peer-reviewed papers. In addition, only studies published since 1990 have been included as this provides a useful comparison against the findings reported in Hembree's (1990) seminal meta-analysis. Furthermore, the review focuses on MA and, accordingly, includes studies that have explicitly measured MA after the intervention; studies that aimed to reduce MA but only measured, for example, maths performance, were excluded. Studies that clearly represent interventions to address MA are reported in Table 1. Finally, we suggest directions for further interventions, considering recent theoretical developments in the field.

Table 1. Mathematics Anxiety (MA) Intervention Studies.

Study	Sample size	Population	Type of intervention	Measures of maths anxiety	Additional outcomes	Main findings
Lavasani & Khandan (2011).	40	Secondary school students (aged 13-14 years), Iran.	Co-operative learning vs. traditional method.	"18-item mathematics anxiety scale".	Help-seeking behaviour.	Co-operative learning resulted in significantly lower MA, decreased help avoidance behaviour and increased help seeking behaviour.
Segumpan & Tan (2018).	90	Secondary school students (aged 12-13 years), Philippines.	Flipped classroom vs. traditional method.	Mathematics Self-Efficacy and Anxiety Questionnaire. (MSEAQ; May, 2009).	Maths performance.	Significantly lower MA and greater maths performance in the flipped classroom condition compared to the control condition post-intervention.

Passolunghi et al (2020).	224 (3 studies; n = 76, n = 76, n = 72)	Fourth grade children, (aged 9-10 years; mean age = 9.60 years; SD = 0.27). Italy	MA training; maths strategy training.	Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003; Caviola et al., 2017).	General anxiety; Primary mental abilities.	Repetition and exposure to maths, including focused training on basic emotions can increase maths ability and decrease MA.
Supekar et al (2015).	28	Third grade children (aged 8-9 years; low & high MA), USA.	Intensive 8-week one-to-one cognitive tutoring program to improve mathematical skills and reduce MA (3 weekly sessions).	Scale for Early Mathematics Anxiety (SEMA; Wu et al., 2012).	Intelligence; Achievement; Working memory; Brain activity.	Sustained exposure to mathematical stimuli can reduce MA.
Alanazi (2020).	60	First grade primary school children (aged 6-7 years), Saudi Arabia.	Active recreational maths games (24 sessions over 2 months; 3 weekly sessions).	Mathematics Anxiety Scale for Children (Chiu & Henry, 1990); Arabic translated (Adnan & Ibrahim, 1990).	Maths performance.	MA was significantly lower in the intervention group post intervention.
Jansen et al (2013).	207	Grades 3-6 primary school children (aged 6-10 years), Netherlands.	Math Garden ("a web-based computer adaptive application for practicing mathematical skills").	The Math Anxiety Scale for Children (Chiu & Henry, 1990); Dutch translated (MASC-NL; Jansen et al., 2013).	Cognitive competence; social competence; general self-worth; maths task performance.	Computer based activity resulted in a small performance improvement, but there was an absence of effect on MA.
Karimi & Kenkatesan (2009).	25	High school students (aged 13-16 years), Iran.	Cognitive Behavioural Group Therapy (CBGT) (15 sessions for 1.5 hours).	Mathematics Anxiety Rating Scale (Alexander & Martray, 1989).	None.	MA reduced following CBGT and suggests that reappraisal may be an effective strategy.
Sheffield & Hunt (2006).	154	Children (aged 10-11 years), UK.	Modified systematic desensitization.	Mathematics Anxiety Scale for Children (MASC; Chiu & Henry, 1990).	Maths performance.	The use of a physiological strategy resulted in decreased MA and improved performance.
Brunyé et al (2013).	36	University students (low & high MA), mean age = 20.80 years, SD = 2.60. USA.	Breathing exercises.	30-item Mathematics Anxiety Rating Scale (MARS; Suinn & Winston, 2003)-but only to define different groups.	Mood; Arithmetic performance.	Focused breathing improved calmness ratings and mitigated maths anxiety effects on arithmetic performance.

Salazar (2019).	106	UG students (aged 18-45 years; mean age = 21.03 years; SD = 0.49. USA.	Colouring Mandalas vs. Free form vs. Doodle before maths problems.	Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003).	None.	Colouring (both groups) was associated with reduced MA (control was not).
Davis & Kahn (2018).	59	Undergraduate students (aged 18-23 years; mean age = 21 years) USA.	Virtual reality relaxation vs. Passive control.	Math Anxiety Rating Scale -Revised (MARS-R; Plake & Parker, 1982).	Maths performance.	Significantly lower MA and higher maths performance between groups post-intervention.
Gan et al (2016).	105	Undergraduate students (aged 19-31 years; mean age = 22.23 years; SD = 2.08). Singapore.	Stimulating vs. Sedative music vs. No music before maths problems.	Abbreviated MARS (Alexander & Martray, 1989).	State anxiety, blood pressure and heart rate.	Sedative music associated with reduced MA and STAI.
Jamieson et al (2016).	93	Community college students (aged 18-58 years; mean age = 29.40 years). USA.	Re-appraisal vs. Suppression Control (Ignore negative cognitions).	Abbreviated Math Anxiety Scale (Hopko et al., 2003).	Stress appraisals; Maths performance.	MA decreased, coping resources increased and performance improved in reappraisal group compared to suppression control. Resource appraisals mediated performance.
Dorothea (2016).	5	Secondary school students (aged 17-19 years). Italy.	Dramatherapy.	"Personal questionnaire" involving a range of items pertaining to MA/stress; Interview.	Maths self-efficacy.	Some descriptive evidence to support a decrease in stress associated with maths, along with increased maths self-efficacy.
Samuel & Warner (2021); Experiment 1.	40	Community college students (mean age 17.92 years). USA.	Combined mindfulness and growth mindset intervention embedded into curriculum vs. Passive Control.	Revised Math Anxiety Rating Scale (RMARS; Alexander & Martray, 1989).	Maths self-efficacy.	MA decreased and self-efficacy decreased in the intervention group but not control group.

According to a Hembree's 1990 meta-analysis, whole-class curricular based changes were shown to be ineffective in reducing MA. Such changes included, for instance, the use of specialist equipment and technology, different instructions and variations in the presentation of material. With the notable increase in availability and power of technology, particularly the rapid gains in internet provision in schools, it may be necessary to further explore the utility of these resources in the context of reducing MA. Recent research has also demonstrated how pedagogical changes may support the reduction of MA in the classroom. Pedagogical approaches facilitate maths learning, and thus arguably support a deficit argument, whereby improving mathematical knowledge and encouraging more effective learning behaviours may contribute to lower MA and improved maths self-efficacy. For instance, Lavasani and Khandan (2011) used a co-operative learning intervention to address MA in Iranian eighth graders by encouraging interactions among

peers and the teacher. The intervention resulted in a significant reduction in MA and an observed increase in help-seeking behaviour, suggesting classroom activities that encourage working together and seeking support reduce avoidance.

Moreover, a study of secondary school students in the Philippines used a flipped classroom approach to successfully reduce MA, possibly due to the greater interactivity and dynamic nature of learning afforded by the approach (Segumpan & Tan, 2018). Group-based formative feedback has been successfully used for students studying statistics (Núñez-Peña et al., 2015), whereby perceived usefulness of feedback predicted exam grades. The authors suggest the feedback approach may have increased students' confidence, which acted as a buffer against MA and/or its effects.More extensive work (Passolunghi et al., 2020) focused on MA prevention in fourth-grade (aged 9-10 years) primary school children in Italy and tested the efficacy of three divergent training methods: (1) MA training (knowledge and recognition of basic emotions); (2) maths strategy training (practising calculation skills); and (3) control training (playful activities on reading/drawing comic strips). MA was measured using the 9-item Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003; Caviola et al., 2017) and maths abilities were measured-in contrast to more traditional simple calculation tasks-using the MAT-M3 (pre-test) and MAT-M4 (post-test) (Amoretti et al., 2007) that consist of a range of tasks, e.g., ranking numbers, solving word problems of various concepts and decomposing numbers, to more validly measure maths performance. The findings showed that maths strategy training both improved maths ability and decreased MA, while MA training was only associated with reducing MA level; no performance improvements were observed. The importance of these findings relates to the efficacy of MA training in supporting the reappraisal of maths, even in younger children. Passolunghi and colleagues (2020) posit that repetition and exposure to maths-as well as focused training on basic emotions-can promote a sense of self-control, which may explain the observed reduction in MA and associated improvement in attainment. This relates to both the deficit theory and debilitating anxiety model, whereby exposure leads to lower anxiety, and thus provides more maths dedicated cognitive capacity.

However, the practical application of targeted strategies is dependent on available resources, including time (curriculum demands) and funding. Aligning with increased attention on functional strategies and child-centred research, Fuchs et al. (2013) investigated the impact of divergent practice types on number knowledge in first-grade children (UK age 6-7 years) at risk of MA. Over a 16-week period, 30-minute tutor-led practice sessions took place thrice weekly for the assigned groups to improve simple addition and subtraction: (1) Number knowledge with speeded practice (cardinality, subtraction as the inverse of addition, quick responding & efficient counting procedures), and (2) Number knowledge with non-speeded practice (careful execution of strategies and

understanding relations & principles that are the basis of reasoning to support retrieval). They found that number knowledge training with speeded practice supports at-risk children's arithmetic competence, as well as complex calculations due to compensating for weak reasoning ability. Extending this work, Supekar and colleagues (2015) state that MA during early childhood has adverse long-term consequences; accordingly, early identification and alleviation is important. Their own research centred on maths training (3 sessions per week) and desensitisation through an intensive 8-week one-to-one cognitive tutoring program, that aimed to improve maths skill and determine whether this could reduce MA. Twenty-eight children in grade three (UK aged 8-9 years) participated, as this was considered a critical early-onset period for MA, although groups were formed using a median split of a normal sample (Sokolowski & Necka, 2016). Pre and post training Functional Magnetic Resonance Imaging (fMRI) was conducted whilst children simultaneously completed simple addition tasks. The post fMRI scans revealed a decrease in local amygdala circuits for those initially identified as high MA-reflecting fMRI data of mildly-anxious children and supporting the debilitating anxiety model of MA. The findings demonstrate the effectiveness of intensive maths tuition. However, this approach requires suitable resources, which may not be available for many given time and curriculum demands. It is also uncertain whether similar effects would be observed in older children or adults.

Recent comparisons between traditional teaching approaches and active recreational maths games (ARMG) have been trialled (Alanazi, 2020). In this research, a sample of 60 first-grade Saudi Arabian primary school children (UK age 6-7 years) were randomly allocated to the control group (n = 32) or experimental group that would participate in three weekly, 45-minute sessions (including counting, subtraction, additions, shapes) over a two-month period, and MA scores were determined using a translated 23-item iteration of the Mathematics Anxiety Scale for Children (Chiu & Henry, 1990; Adnan & Ibrahim, 1990). Performance was measured by a test created that aligned with the curriculum and was validated by six maths education experts. The findings showed a significant decline in self-reported MA at post test for the experimental group, whereas an increase was observed for the control group, indicating that traditional approaches may not be effective and supportive for emotions and deeper processing. The findings also showed a significant performance improvement for the experimental group, supporting ARMG as a potentially effective MA strategy and general approach to teaching maths. However, this strategy requires further testing with a larger and more demographically diverse population. Nonetheless, studies that have implemented and reported targeted strategies appears to show a trend of reducing MA, and-to an extent-promoting maths attainment. Alanazi (2020) suggests that this may be associated with supporting self-concept, self-esteem (Hughes, 2003), self-confidence and, crucially, self-efficacy (Pajares & Graham, 1999). Jansen and colleagues (2003) manipulated perceived success rates on a computer-

based maths task completed by primary school children (aged 6-10 years). Whilst they found higher perceived success was associated with more future attempts and ultimately greater real success, interestingly there was an absence of effect on MA. These findings suggest that whilst such interventions are beneficial in certain ways, e.g., enhancing maths self-efficacy and/or maths attainment, they fail to consistently reduce MA.

It is worth noting that Lazarides and Ittel (2012) observed a range of individual differences in children's judgements of instructional quality in maths classes. This serves to demonstrate the complexity of factors that are involved in the formation of children's maths attitudes, especially as they found such judgements to be associated with self-concept and interest in maths. However, targeted strategies such as MA training, maths strategy training and ARMG may be associated with explanatory styles in response to difficulties, thus impacting MA levels. According to previous work (Yates, 2002), pessimism in maths is associated with a decrease in persistence and assertiveness, and early optimism links with constructive work habits in later education. Optimism has also been shown to relate to confidence in decision making, mental rigidity and emotional intelligence. In contrast, pessimism relates to worry, despair, guilt and depression (Al-Ansari, 2003). This places emphasis on early strategies and for educators to have a greater understanding of emotional and empirically supported responses associated with maths, with emphasis on promoting a positive outlook. We consider corresponding research and strategies within this paper. Indeed, such strategies may have a positive impact on the negative relationship observed between MA and attainment. Ramirez et al. (2016) explored this association with an emphasis on problem-solving strategies which, in young children, are rudimentary (e.g., finger counting) but eventually develop problem-answer associations such as understanding that $3 + 3 = 6$. Building on this, children begin to use strategies such as retrieval, decomposition and reconstruction, although this is a more working memory intensive strategy (Ramirez et al., 2016). In their work, it was found that MA in UK children (aged 6-8 years) disrupted working memory capacity, preventing those with high MA from utilising more advanced problem-solving methods. Therefore, targeted strategies that reduce MA-lessening the demand on working memory (debilitating anxiety model)-should be trialled and more widely adopted in classrooms as standard practice. Concerning emotions and MA, Karimi and colleagues (2009) conducted research with 25 high school students aged 13-16 years who were measured for MA through the RMARS (Alexander & Martray, 1989). The 5-point Likert scale included 12-items relating to maths test anxiety and 13-items gauging anxiety in relation to completing mathematical tasks. Following completion of the RMARS, students were either assigned to a control or experimental group. The experimental group engaged with Cognitive Behavioural Group Therapy (CBGT) that was conducted over 15 sessions, in which participants identified their negative thoughts and learnt how to cope with these. The RMARS was completed again, following the conclusion of consistent and

intensive CBGT. The results indicated that MA scores had significantly decreased at post intervention. This supports the notion that MA is a negative emotional response affecting cognitions, rather than an intellectual deficit (Luo et al., 2009) and reappraisal may be an effective strategy to addressing the implications of the debilitating anxiety model. Similarly, Lyons and Beilock (2012) demonstrated that those with high levels of MA have increased activity in the frontoparietal network that is involved in the regulation of emotion, through simply anticipating a maths task. Yet, when those high in MA are taught strategies to regulate negative emotions, they perform at an equivalent level to those with low MA. This demonstrates that an emotional element is influential in the maintenance of MA and can be alleviated to reveal genuine ability.

Given the consistent finding that MA is negatively related to willingness to pursue future study or work involving maths (Chipman et al., 2002; Ahmed, 2018) it may be that interventions are required to support initial engagement. This may be necessary, for example, for students who are afraid of entering a maths class, let alone engage with maths learning or problem solving. Sheffield and Hunt (2006) used a modified systematic desensitisation approach with older children aged between 10-11 years. MA scores were determined through the Mathematics Anxiety Scale for Children (MASC; Chiu & Henry, 1990) and performance was assessed on several addition problems. Children practiced relaxing diaphragmatic breathing whilst imagining a maths situation to reduce anxiety. They were further exposed to progressively more difficult maths problems whilst performing relaxing breathing. At one and five weeks later, children again completed the MASC. Analysis of results revealed that those in the intervention group had decreased anxiety and improved performance at post 1 week and 5 weeks. This indicated the value of physiological type strategies to address MA, although further work is required given the existence of baseline differences between the groups. It may be that a systematic approach involving physical relaxation is required for those individuals with a particularly high level of MA, especially as recent work has highlighted a brain response associated with the processing of even basic numerical information (Batashvili et al., 2019).

There are some recent studies that demonstrate the value of interventions that combine relaxation with a focus on attention. For instance, Brunyé and colleagues (2013) adopted a focused breathing technique. Using mindful, diaphragmatic breathing and training individuals to refocus their attention, they found performance of high maths anxious students approached that of those low in MA. Salazar (2019) observed a positive effect of colouring mandalas on MA. A group of undergraduate students were instructed to colour in mandalas (either structured or unstructured drawings), whereas a control group was instructed to simply doodle. Salazar found that MA significantly reduced in the colouring condition and no significant reduction was seen in those who doodled. The

author emphasises the benefits of such colouring as a therapeutic technique that induces both cognitive and physical calm. In another study, Davis and Kahn (2018) report on the use of virtual reality in the classroom as a moderator of the relationship between MA and performance. They demonstrated that calming scenarios presented via virtual reality reduced MA and improved performance compared to a control group. Furthermore, Gan and colleagues (2016) demonstrated how attending to sedative music during a maths task can be beneficial for students. They measured state anxiety, MA, and a range of physiological measures before, during, and after a maths task. Participants were assigned to one of three groups: sedative music, stimulative music, or no music. Results showed that state anxiety and systolic blood pressure were significantly reduced when participants listened to sedative music, leading Gan et al. to explain the findings using a perception-to-physiology model, whereby the sedative music first reduced perceived anxiety and this, in turn, reduced physical relaxation over time.

The longevity of treatment effects should also be considered. For instance, an early intervention to address MA (Bander et al., 1982) observed a positive effect of a cue-controlled relaxation technique at a three-week follow-up, compared to a range of other approaches, including study skills training and combined treatments. The varied studies and findings show the value of considering strategies that target physical relaxation but also those that facilitate focusing of one's attention. Arguably, this aids the directing of attention away from unhelpful, worrisome thoughts and enables those with high anxiety to gain attentional control (Eysenck et al., 2007). An alternative approach to training people to manage maths anxious feelings and sensations has been put forward by Jamieson and colleagues (2016). They examined the effects of reinterpreted reappraisal on performance. Participants were faced with an anxiety evoking task, some were told anxious feelings were beneficial to their performance, others were instructed to ignore negative thoughts associated with stress during exams. Individuals who had been reappraised to see anxiety as beneficial i) performed better, as indexed by exam grade, than controls and ii) had lower maths evaluation anxiety. Rather than aiming for physical relaxation, this approach emphasises one's mindset. It normalises anxious feelings and encourages a challenge and approach response to maths, rather than a threat and avoidant response (Jones et al., 2009).

Some studies have tested the impact of expressive writing on maths performance, based on previous findings that writing down worries and fears can help control worry (Klein & Boals, 2001). Ramirez and Beilock (2011) examined whether expressive writing with ninth grade students (UK aged 14-15 years) supports mathematical performance. Compared to control conditions, students that wrote expressively-and specifically about their test-related worries-before a high-pressure maths test demonstrated a significant increase in accuracy at post-test. Similar findings were observed in an additional study

(Ramirez and Beilock, 2011) that focused on test-anxious students (low and high), again demonstrating the effectiveness of expressive writing under high-pressure, as opposed to low-pressure conditions. Further to this work Park and colleagues (2014) investigated expressive writing in the context of MA by asking University students to write down (to express) their thoughts and feelings prior to a maths test. Compared to a control condition, they found the difference in performance of low and high maths anxious individuals was significantly reduced following expressive writing. Moreover, they observed a positive relationship between the number of anxiety-related words that were written and students' performance. Expressive writing is thought to increase the availability of working memory resources (Klein & Boals, 2001; Yogo & Fujihara, 2008). As such, the effectiveness of an expressive writing strategy may provide support for a debilitating anxiety model of MA. However, these studies have not explicitly measured changes in self-reported MA, so conclusions should be viewed with caution. As an alternative strategy Dorothea (2016) reports on the use of psychodrama group therapy for the treatment of high maths anxious pupils in a secondary school. Like expressive writing, this therapy encourages the expression of thoughts and feelings. It also provides a safe place for individuals to re-enact previous experiences, e.g., receiving a low maths grade. Whilst Dorothea provides some promising findings, limited conclusions can be drawn given the small sample size (five) and reliance on descriptive analyses.

Future Directions

The role of parents has become increasingly acknowledged as an important factor associated with children's MA. Maloney et al. (2015) explored the effects of parents' MA on their children's maths achievement and anxiety over the course of a school year. Findings showed that children's achievement and anxiety were higher at the end of the school year if their parents were highly maths anxious. However, this was only the case when those parents reported frequently helping their children with homework. Maloney and colleagues suggest this provides evidence of an intergenerational effect. Importantly, parents' MA did not predict children's reading achievement, suggesting that children's maths achievement is specifically affected by parental MA. Relatedly, Berkowitz et al. (2015) considered the role that home life has on maths achievement. They suggest that many parents consider maths education to be the responsibility of schools, overlooking the importance of the home learning environment on children's success in maths. They also consider that in cases when parents experience high MA, they will typically avoid talking about maths with their child. Yet, in cases when they do, the quality of their input is low, which may support the findings of Maloney and colleagues (2015). Berkowitz et al. (2015) conducted research with 587 first-grade children (UK aged 6-7 years) and focused on testing an educational intervention to promote interactions between children and parents relating to maths. The intervention took the form of an iPad application

that included maths passages, with associated questions and covered topics including counting fluency, geometry and arithmetic, which children and parents could complete together. A control group was also incorporated, and children and parents completed tasks that related to reading comprehension, vocabulary, phonics and spellings. The results showed that the more frequently parents and their children used the app each week, the higher children's maths achievement was at the end of the school year. This was a finding that was only evident for the maths group and demonstrated that maths achievement in school is related to the home learning environment. Moreover, children of high anxious parents who used the application more frequently had higher maths achievement at the end of the year than children of high anxious parents who did not use the application frequently. Whilst these findings may appear at odds with those of Maloney et al. (2015) they could point towards the quality of parent-child interactions, particularly in relation to supporting parents with current maths learning practices. As such, future work should focus on strategies that support parents' understanding of modern approaches in maths education and scaffold the maths support they provide to their children.

There is also evidence that parents' maths attitudes influence the development of children's maths attitudes (Dowker et al., 2012; Vukovic et al., 2013). Through focus groups with young children (aged 4-7 years) in the UK, Petronzi and colleagues (2017) found that positive attitudes were associated with children being assured that their parents would assist them with their maths work. Mazzocco et al. (2012) stated that it is crucial for parents to promote the value of maths, although this assumes that parents are able to extinguish negative attitudes that they may have. Indeed, Fraser and Honeyford (2013) considered that some parents may not value achievement in maths, and children are susceptible to learning and adopting this same belief through transference of attitudes (Rossnan, 2006; Gunderson et al., 2012) particularly if they are expressive of their personal difficulties with maths to their children (Erden & Akgül, 2010). Exposure to such attitudes may affect the extent to which children engage with maths. The work of Else-Quest and colleagues (2008) provides some insight. In assessing behavioural expression of emotions among 165 mother-child dyads, the researchers observed significant positive correlations in the emotions expressed between mothers and their children during mathematical problem solving at home. Emotions included positive ones, such as joy, pride and humour, whereas negative emotions included frustration, sadness and contempt. The authors discuss these findings in relation to emotional contagion: the way in which one person may mimic another's emotional expressions automatically and without conscious thought (Hatfield et al., 1993). As Else-Quest et al. (2008) point out, such correlations in expressed emotion may highlight the way in which parents can shape their child's emotions during homework interactions. It may also emphasise the need for parents to carefully monitor and regulate their own emotions; detailed analysis showed that mothers were more likely to display contempt during maths-learning interactions

following their child's earlier poor performance. Future interventions should target parents' understanding of their own attitudes and behaviours and enable them to manage their interactions with their children effectively.

Pessimism and negative attitudes in maths are associated with low self-efficacy (Zimmerman, 2000) and motivational and cognitive deficits (Kolacinski , 2003). Ramirez and colleagues (2018) discuss MA in relation to negative appraisals of previous maths experiences. A key tenet of this proposition is that "dysfunctional self-schemas" can develop, which negatively affect a person's appraisal of their own ability to do well in maths (Ahmed et al., 2012). That is, MA is related to a greater propensity to view one's past maths performance as worse than it really was. According to Ramirez and colleagues (2018), this may explain why maths self-concept is such a strong predictor of maths performance. Further to this, the authors refer to finding that motivation moderates the relationship between MA and performance (Wang et al., 2015). These findings have suggested that people with low intrinsic motivation may be less likely to use positive appraisal processes. Instead, they may focus on negative thoughts and worries, thus disrupting working memory. Recent support for this argument is provided by O'Leary and colleagues (2017). They found significantly higher MA among participants who reported specific negative past experiences involving others (e.g., a teacher), including people who participants perceived as having increased their MA or lowered their confidence. Appraisals of previous experiences could involve a disproportionate and unhelpful focus on negative events. It is also feasible that neutral maths experiences are appraised negatively, but further work is needed to assess this. Nevertheless, such findings provide a new direction for strategies designed to alleviate MA. In particular, work on instructional framing has shown that framing instructions in a positive way can facilitate a challenge appraisal of an upcoming maths task (Feinberg & Aiello, 2010). Future research should consider whether changes to instructional framing also reduce MA. It would also be worthwhile assessing the efficacy of strategies that address maladaptive appraisals of previous maths experiences.

According to Mazzocco (2007) teachers do children a disservice when demonstrating a dislike of maths due to the influence of their attitudes on children's maths performance. Rahim and Koeslag (2005) proposed anxiety reduction in junior and intermediate pre-service teachers as an early intervention. They suggest that teachers should study their feelings of discomfort with numeracy and maths as a logical step. By alleviating maths worries in teachers, they should be more suitably prepared for students they encounter with similar feelings, and not convey negativity to the children, or intensify any underlying numeracy worries. Hamlett (2008) designed and implemented a ultiliteracy unit to provide pre-service teachers with the opportunity to tackle their specific mathematical difficulties and anxiety, through a variety of methods, including

group work; self-paced work, use of websites, pen and paperwork, practical tasks, and access to a skilled tutor. The unit aimed to encourage and build mathematical confidence and familiarise the students with concepts and strategies that they may have forgotten. Moreover, Hamlett (2008) discussed motivation, task completion, and seeking help as behaviours that lead to success, which the unit further attempted to promote. Results indicated that confidence ratings had improved, but pre-service students maintained low confidence about teaching a skill as opposed to performing the task themselves. This was despite a decrease in anxiety and stress as competence increased.

We also recommend consideration of cognitive growth theories and strategies in terms of MA and understanding why some children may encounter more difficulties than others. Mindset Theory differentiates between a fixed mind set and growth mind set (Dweck, 2006). A fixed mind set relates to children viewing their intelligence as stationary and effort as ineffective. Linking with an Entity Theory (Dweck et al., 1993), a person may feel that circumstances are outside their control in terms of having no power or ability to change the situation, which may lead to disengagement, frustration, and avoidance. In contrast, a growth mind set treats intelligence as fluid and changeable, and students gain satisfaction from the process of learning. For these, effort is valuable, and setbacks are met with feedback with which to build knowledge. This relates to an incremental view that considers students as aiming to master challenges and implement functional strategies when faced with difficulties. Samuel and Warner (2021) combined mindfulness and growth mindset intervention to reduce MA in college students enrolled on a statistics course. The intervention included: (1) explaining the principles of growth mindset theories, (2) a 1-minute deep breathing exercise before each statistics class (and being asked to think only about the present moment), (3) reciting five positive affirmations about maths (e.g. 'I am capable of understanding math'), (4) students being asked to be actively engaged in sessions, to use breathing techniques when feeling anxious, to reinforce effort and to offer verbal praise, (5) fixed mindset statements were reframed to represent growth mindset. Statistical data showed promising results for the strategy group, in that MA scores decreased at post intervention when compared to pre-intervention scores. In addition, qualitative findings indicated that the strategies supported students in calming down and thinking more clearly, providing support for the debilitating anxiety model. Furthermore, positive affirmations seemed to create a sense of belief in ability, as well as having control of emotions, particularly stress and feeling overwhelmed. Further research is required to extend this work with a particular focus on positive affirmation and self-regulation of anxiety. Such work aligns with findings that interventions based on cognitive restructuring are particularly effective at reducing MA (Hembree, 1990), as well as recent developments regarding mathematical resilience (Johnston-Wilder & Lee, 2010; Johnston-Wilder et al., 2016).

Metacognition is a key strategy in current education, which builds on the idea of incremental learning and counters the idea of fixed intelligence. Metacognition centres on how learners monitor and purposefully direct their learning; it relates to understanding and adapting cognitive strategies, e.g., memorization strategies or subject specific strategies to control cognition. Essentially, students are taught to plan, monitor and evaluative their learning, and is based on principles including modelling and promoting metacognitive discussions in the classroom Education Endowment Foundation, 2018). Morsanyi and et al. (2019) consider metacognition in the context of MA, whereby MA inhibits the efficiency of monitoring and control. Specifically, high maths anxious students may be less flexible in applying alternative strategies; they may set lower attainment goals, have lower confidence throughout the problem-solving process, and may discontinue the task (Jiang et al., 2021) However, Morsanyi and colleagues (2019) consider that high MA may increase cognitive effort to mitigate the adverse impact of anxiety and may therefore result in greater monitoring and control process e.g., more time devoted to a task and double-checking responses. Given the movement towards metacognitive strategies, this warrants further research and strategy implementation in the context of MA. This aligns with considerations that the focus should not be solely on reducing MA; there should be a focus on minimising the risk of developing MA through targeted exercises (to improve basic skills) and to support understanding and regulation of anxiety (Maloney & Beilock, 2012) to prevent a 'snowball' effect (Ramirez et al., 2013).

Targeted strategies have applied principles of reflection, for example, bibliotherapy (Wilson, 2009). Previously used to support pre-service teachers with MA, bibliotherapy follows a 4-step process in which the reader: (1) identifies with a protagonist, (2) becomes emotionally involved and releases emotions, (3) becomes aware that their problem can be resolved, and (4) becomes aware that their issue is not unique to them. Wilson (2009) reported that the process elicited strong emotional responses in participants, which supported a perceived change in feelings towards the specific threat. In an ongoing study, Petronzi and colleagues (2021) designed a targeted storybook approach for addressing MA that can directly address issues of optimism and pessimism (Yates, 2002). As a strategy, the storybook approach can discuss feelings and issues about maths (as well as solutions) in a format that facilitates reflection for younger children who are perhaps unable to effectively apply this skill independently, or who may already be experiencing debilitating anxiety. This may specifically relate to self-regulation and metacognition.

As shown in Table 1, existing intervention studies have relied on a range of self-report MA scales to measure MA. In order not to compromise validity, it is important that such self-report measures are selected based on the specific population under study. However, it is also worth noting differences in the underlying factor structure of the various self-report scales, which emphasises the multidimensional nature of MA. This is important

in the context of interventions and the way their efficacy is evaluated. For instance, Jamieson et al. (2016) observed an effect of reappraisal on the maths evaluation subscale of the Abbreviated Mathematics Anxiety Scale (Hopko et al., 2003; Caviola et al., 2017) but no effect on the maths learning subscale. Many of the existing intervention studies have failed to consider the factors that comprise the scales used, which potentially limits understanding of the impact. Thus, future intervention studies need to consider assessment using sub-scales relevant to the nature of the intervention, i.e., those that are learning based and those that are evaluation based.

A further consideration is whether intervention studies are assessing the impact on short-lived reductions in anxiety or whether such reductions are maintained. State anxiety relates to the potential range of situations-or threats-that may cause temporary anxiety, leading to the experience of unpleasant emotional arousal and physiological responses that impact efficiency and performance. For those with high MA, this may be a maths lesson, examination or an everyday situation that requires the manipulation of numbers, particularly in situations perceived as high pressure. In contrast, trait anxiety refers to the general tendency to respond with anxiety to perceived threats, and, crucially, is a stable characteristic of the individual. Correspondingly, those with higher trait anxiety experience state anxiety more frequently and in higher magnitude (Spielberger, 1985). Trait anxiety is particularly triggered by perceived threats to performance (anticipated failure) (Horikawa & Yagi, 2012). In the context of MA, a reliance on trait-based MA scales to measure the impact of interventions may fail to capture the full extent of changes in state anxiety. Furthermore, the absence of follow-up testing in many studies creates uncertainty over the longevity of any positive effects that have been observed. Moreover, existing studies have tended to either measure MA explicitly using self-report measures or assume changes in behavioural outcomes (such as maths performance) are indirectly accounted for by changes in MA.

However, findings have demonstrated that maths achievement is better predicted by implicit and explicit MA combined (Westfall et al., 2020). Therefore, it may be necessary for future intervention work to include both implicit and explicit measures of MA in order to fully understand attempts to address MA. With regards to limited follow-up of the long-term effects of MA interventions, future work in this area could also examine the cumulative effects of MA, which are relatively unknown and could relate to the Allostatic Load Framework (McEwan, 1998). This theory considers the impact of stress/anxiety from a psychological/physiological perspective and the bodily reactions and psychosomatic outcomes (headaches, fatigue, sleep interruptions) that are amplified during periods of prolonged stress/anxiety, e.g., when somebody consistently experiences MA in a range of maths related situations.

Since Hembree's (1990) meta-analysis, several interventions have taken a whole-class

approach, whether that is a new teaching/learning approach, or a psychological approach. In most cases this appears to have resulted in decreases in maths anxiety and, in many cases, improvements in maths performance. This marks a change from the conclusions drawn from Hembree's meta-analytic findings and suggests a whole-class approach can work, provided the intervention itself is suitable. There were a number of additional strengths and weaknesses of the reviewed studies. Most included the use of control groups and, in many cases, randomisation, which together allow causality to be determined. However, there was limited evidence of blinding of assessors. Moreover, most studies involved small samples and are likely to be underpowered to detect moderate effects. Some also reported participant withdrawal/attrition e.g., missing multiple intervention-based sessions, without providing details of the individual characteristics of those participants; intention to treat analyses were not reported (Fergusson et al., 2002).

Conclusion and Recommendations

The existence of MA across a range of countries, and therefore, educational systems, is evidenced through the studies considered in this review. Despite the suggestion that people experience intrinsically positive attitudes towards maths (Nicolaidou & Philippou, 2003), research has indicated that MA can develop in children as young as four years of age (Petronzi et al., 2017) with attitudes formed because of classroom-based negativity (Fraser et al., 2013). Therefore, it is important that suitable strategies are implemented in early schooling to minimise the development or exacerbation of MA. Changes in pedagogical practices may be beneficial in enhancing maths self-efficacy and helpful learning behaviours, sometimes effectively addressing MA. Those strategies that appear to be most effective in addressing MA are those that facilitate cognitive control, with an emphasis on attentional processes and emotion regulation. Thus, in the main, these studies provide support for the debilitating anxiety model. Whilst neurophysiological studies offer insight into our understanding of MA, we recommend a move away from potential strategies that are resource intensive. We propose the need for targeted strategies that are time and cost effective, especially those that lend themselves to a range of educational contexts, such as the home and virtual learning environment. Since MA is associated with avoidance (Chinn, 2012; Choe et al., 2019), as a starting point it is important that academic settings are inviting and encourage greater participation among maths learners (Hlalele, 2012). Pedagogical strategies that include a degree of co-construction may also encourage engagement and enjoyment, highlighting the relevance of maths. It is likely that a reciprocal relationship exists between MA and maths performance (Carey et al., 2016). As such, the designs of extant interventions make it difficult to determine the precise theoretical mechanisms that underpin the observed effects. Future work would benefit from testing a wider range of hypotheses pertaining to plausible targets associated with MA, including maths self-efficacy, social support, growth mindset and resilience.

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About the Authors

Dominic Petronzi is a lecturer in psychology at the University of Derby. He is a member of the University's Mathematics Anxiety Research Group (MARG) and his PhD focused on exploring and understanding when mathematics anxiety develops in children and what contributes towards this. This work led to a valid and reliable assessment measure for children's mathematics anxiety. Since then, he has continued to research this area with a current focus on functional strategies, publishing research and delivering training sessions. Email: d.petronzi@derby.ac.uk, ORCID iD, https://orcid.org/0000-0002-3872-2725, ResearchGate, https://www.researchgate.net/profile/Dominic-Petronzi

Thomas Hunt is an Associate Professor in Psychology at the University of Derby, UK. He leads the University's Mathematics Anxiety Research Group and works with a range of academics and stakeholders worldwide. He primarily publishes in interdisciplinary

education and psychology journals. Email: t.hunt@derby.ac.uk, ORCID iD: https://orcid.org/0000-0001-5769-1154 ,ResearchGate: https://www.researchgate.net/profile/Thomas-Hunt-2 , Twitter: @dr_tom_hunt

David Sheffield is a Professor of Psychology at the University of Derby in the United Kingdom. His research aims to understand the impact of stress on health, wellbeing and performance. He uses a range of methodologies (e.g. epidemiological, experimental, psychophysiological, interviews) to elucidate mechanisms and develop interventions. His current research interests include: Maths anxiety; Music and well-being; Pain and pain management in patients and athletes; Compassion and mindfulness-based approaches to living; Inequalities and justice in healthcare; and Cardiovascular responses to stress. Email: d.sheffield@derby.ac.uk ; ORCID iD, https://orcid.org/0000-0001-9121-1783 ; ResearchGate, https://www.researchgate.net/profile/

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Alternative Method in Teaching Statistics: Creative Drama

Zeynep Sonay AY
Hacettepe University

Seyda AYDIN
Hacettepe University

Creative drama is an active, interactive and reflective means of playing and practicing life (Adıgüzel, 2006) based on working in a shared role (Baldwin, 2009). Creative drama is used to teach subjects other than the drama's own subjects by employing the techniques it has. These subjects can be from any school subject or discipline whose objectives can be addressed with creative drama. In this method, it is possible to teach a subject to be covered in a dramatic study by allowing students to experience it personally by means of enacting (Adıgüzel, 2018). Creative drama is enacting with a group by using techniques such as improvisation, role playing and by making use of the experiences of the group (Adıgüzel, 2006).

Teachers and students actively recreate, change and adapt their perceptions of the world and people as they work in role through drama (McNaughton, 2004). It allows the participant to look at other people's lives in another time and place, or to examine one's own experiences as a result of an event (Adıgüzel, 2006). Creative drama focuses on the learning process rather than learning outcomes (San, 1998). It is a student-centred process in which experiential learning developed within a curriculum in the classroom environment can be promoted. Creative drama fosters the development of the skills of versatile thinking, creativity, oral and written communication (Annarella, 1992). With creative drama, it can be contributed to the training of students who can research, question, and internalize the desire for curiosity and discovery (Adıgüzel, 2018). It is one of the effective and innovative methods used in the construction of student-centred and constructivist mathematics teaching in mathematics education. The contribution of the creative drama method is important in the process of training students who adopt process-oriented thinking, solve problems, think and share what they think (Özsoy, 2010). When drama is used as a method, the possibility of the learner to make the information meaningful and useful increases (Bowell & Heap, 2019). Adıgüzel (2018) argues that as a method, creative drama is used to teach subjects other than the drama's own subjects by employing the techniques it has. The teacher uses drama techniques in order to achieve pre-determined objectives such as conveying information, arousing interest, solving problems and changing attitudes (McCaslin, 2016). In the lessons where creative drama is used as a method, it should be written in a plan. In drama activities, Answers to questions such as what, why, when, how, where, who, to whom (with whom)

constitute the whole configuration of the creative drama process (Adıgüzel, 2006). The lesson plan has to follow the stages of a) preparation-warm-up activities, b) role play/ improvisations and c) evaluation (Adıgüzel, 2006). Preparation-warm-up activities enable the participants to focus their attention. Activities directed to the establishment of trust and harmony can be implemented to create group dynamics. Interactive games are used effectively at this stage. The enacting stage includes activities through which a subject is formed, determined, shaped and exhibited to other participants (Adıgüzel, 2018). In the evaluation stage, evaluations are made as to whether the pre-determined objective has been achieved.

In the teaching process in which creative drama is used as a method, it is possible to teach a subject in a dramatic conflict, that is, in a dramatic structure, by using the techniques of creative drama through enacting and by making students experience the events (Adıgüzel, 2018; Metinnam, 2019). Although drama is used to teach a subject, the art form of drama must be used (Bowell & Heap, 2019). The leader should be able to discover the tension, conflict or the point of greatest interest and guide the class through an original work (McCaslin, 1996). The aim here is not only to enable the student to enact, but also to enable the student to ask questions and question the learning context (O'Toole & O'Mara, 2007). The leader should enable students to see the deep meaning underlying the subject addressed with drama and gain a deeper understanding (McCaslin, 1996; Metinnam, 2019). In the creative drama process, it is very important that the activities are interconnected, support each other and the role of the activities in achieving the objective should be determined (Adıgüzel, 2006). Components based on dramatic fiction such as role, tension, character, place, symbol, focus, language need to be addressed in the process (Adıgüzel, 2018). A leader who wants to use creative drama as a method should have both the subject area knowledge and the content knowledge of creative drama (Metinnam, 2019).

Living in a constantly developing and changing world may require encountering statistics in many areas of daily life. Statistics is no longer a field that we come across only in textbooks and academic studies. It has become a part of our daily life. Statistical content is encountered on television, in the news, on the Internet, in newspapers, advertisements, billboards and many other places. Especially, the process of struggling with a major pandemic has made it possible to understand how data and statistics come to the fore in daily life. Statistics is needed to make sense of the data encountered and to make inferences. Statistics is defined as a science in which data is collected for relevant questions, the collected data is organized and summarized, and these summarized data are analyzed and conclusions are drawn (Bluman, 2012). Statistics has an important place in international and national curricula. Within the scope of data analysis and probability, which is considered as one of the National Council of Teachers of Mathematics (2000)

standards, it is aimed to enable students to formulate questions, collect data to answer questions, organize data, describe data, use appropriate statistical methods in data analysis, and make predictions and inferences based on data. In the Ministry of National Education Curriculum (Ministry of National Education [MoNE], 2018), it is aimed to enable students to create researchable questions, collect data for research questions, analyse the collected data and interpret the results within the scope of data processing learning area in the mathematics curriculum. The data analysis process is the critical stage for the accomplishment of these objectives. One of the methods used in the data analysis process is measures of central tendency (Van de Walle et al., 2013). Measures of central tendency refer to a method that provides visual images such as graphical representations about data and consist of the concept of mean called arithmetic mean, median, and mode (Van de Walle et al., 2013). The arithmetic mean is defined as the number at which the values in the data group are equalized or as the equilibrium point of the elements (Van de Walle et al., 2013). The arithmetic mean can be found operationally by summing the data in the data group and dividing it by the number of data (Bluman, 2012; Keskin-Oğan & Öztürk, 2019; Van de Walle et al., 2013). The median is the value in the middle of the sequenced data set (Bluman, 2012; Van de Walle et al., 2013; Keskin-Oğan & Öztürk, 2019). The mode is the most commonly encountered value in the data set (Bluman, 2012; Keskin-Oğan & Öztürk, 2019; Van de Walle et al., 2013).

Measures of central tendency have been researched both operationally and conceptually from past to present in the literature. In their study conducted on undergraduate students, Pollatsek, Lima and Well (1981) observed that while some of the students could easily calculate the arithmetic mean of a data set, a surprisingly large proportion of the participants did not understand the concept of arithmetic mean and that among many undergraduate students, the perception that arithmetic mean is about calculation rather than a conceptual structure and that the arithmetic mean starts and ends with a simple formula is quite common. In the study conducted by Leavy and O'Loughlin (2006) with the participation of pre-service elementary school teachers, it was observed that one-fourth of the pre-service teachers learned the concept of arithmetic mean conceptually and used it correctly, one-third of the pre-service teachers could use it limitedly, and that the pre-service teachers confused the arithmetic mean with the mode in graphical representations. Similarly, Groth and Bergner (2006) in their study with pre-service elementary teachers concluded that the majority of the pre-service teachers calculated and interpreted the concepts of arithmetic mean, median and mode, but that they were quite inadequate in choosing the appropriate one out of these three measures. In the study conducted by Koparan (2015) with 10 middle school mathematics teachers to reveal the opinions of the teachers about the difficulties in learning and teaching secondary school statistics, it was concluded that the teachers think that it is positive that secondary school statistics subjects are taught gradually through each grade level and that their

students can make calculations about measures of central tendency, but they do not know how to apply and interpret these measures. Strauss and Bichler (1988) tested whether children realize whether the arithmetic mean is between the extreme values in the data group, evaluate whether the arithmetic mean can be equal to one of the values in the data group, and whether they take the zero in the data group into account when calculating the arithmetic mean of the data group. They concluded that the children were not aware that the zero in the data group affected the arithmetic mean of the data group, they were aware that the arithmetic mean would be between the extreme values in the data group, and they were aware that the arithmetic mean did not have to be equal to one of the values in the data group.

Cai (2000) conducted it to examine how sixth grade students perceive and represent the arithmetic mean algorithm from an international perspective. It was concluded that the students used algorithm and guessing and checking strategies while solving arithmetic mean problems, they mostly used algebraic representations when solving problems, and they had problems in applying the arithmetic mean algorithm in reverse. It was emphasized that this situation was not due to the students' lack of procedural knowledge about the arithmetic mean algorithm, but to the lack of conceptual perception of the arithmetic mean. Zawojewski and Shaughnessy (2000) conducted a study to evaluate students' understanding of central tendency regarding the concepts of arithmetic mean and median. In their research, it was reported that only one-third of the students were able to determine the median given a set of unsorted data, and students did not attach importance to calculating the arithmetic mean and median. Statistics is a method. It is very important that the contexts used in teaching statistics should be related to daily life situations and problems. There are many studies in the literature on measures of central tendency. The results of these studies show that it is important to take an active role in all stages of the research in the process of learning these subjects (Gal, 2000; Van de Walle et al, 2013; Yılmaz, 2019), that it is necessary to evaluate the research process as a whole (Randall, 2006) and that shows that it would be beneficial to include research questions in the process (Randall, 2006; Van de Walle et al, 2013).

In the creative drama process, students produce creative ideas by using statistical information on real life situations that they might not encounter otherwise. They can play a role in a fictional world created with creative drama and produces and discusses statistical creative ideas in that role. Creative drama is used to reflect and experience real situations. Students generate and discuss ideas both having fun and taking part in dramatic fiction. The effects of the delivery of mathematics teaching through creative drama providing student-centred learning environment on both students' achievements and attitudes have been well established in the literature. According to the results of the meta-analysis studies, it has been concluded that the creative drama method is a very

effective method in increasing mathematics achievement (Alacapınar & Uysal 2020, Cantürk-Günhan 2016). At the same time, it is a method that supports students' desire to research, question, wonder and explore (Adıgüzel, 2019) and increases the possibility of the learner to make the information meaningful and useful (Bowell & Heap, 2019). From this point of view, the use of creative drama method in the teaching of central tendency measures, in which it is important to actively participate in the process and make sense of the concepts, will be effective.

An example lesson plan was prepared according to the drama process for teaching central tendency is given below. Teaching measures of central tendency through creative drama by pre-service elementary school teachers, a 3-class hour lesson plan was developed to address the objectives of "*Finds and interprets measures of central tendency belonging to a data group", "Creates and interprets graphs", "Develops a strategy to solve a mathematical problem*". The situation, which was considered on the basis of dramatic scene, was inspired by the problem of The Summer Jobs Problem (Johnson & Lesh 2003). The dramatic situation takes place in an amusement park. In the warm-up activity, there is an activity that motivates, provides mental and physical warming, accompanied by the most played music in amusement parks. Role play/improvisations part, due to financial difficulties experienced by an amusement park business dismissal is discussed. At this stage, students are given two different tables. In the first table, the groups of employees' data for previous year presented that were put forward by the participants in the second activity. This data shows the money they brought to the business last summer (June, July, and August) at different densities (very, moderately, little). The second table gives the results of a survey conducted in the park last year. It shows the answers to the question "*Which one would you like to buy most in the park?*", "*What is expected from the participants is that they make defences by data in tables and their life experience for stay work*". During the reflection and evaluation phase, they are asked to solve and discuss the problem in detail. The teacher asks some questions like, "*What are the statistical concepts that you think about/use in the process and in solving the problem?", "Where and how did you use these concepts to work?", "Why did you prefer to use these concepts?*". The statistical concepts, scientific methods, the graphs are discussed at that moment. The activities were developed and implemented by the researchers. After implementation, the lesson plan has been finalized its final form.

A Sample Creative Drama Lesson Plan

Course: Mathematics

Place: Drama Workshop

Subjects: Measures of central tendency (arithmetic mean, median, mode)

Group: 18-20 participants, aged at 18-22

Duration: 120 minutes (40+40+40)

Techniques: Creative drama (improvisation, role-play, the teacher's having a role, simultaneous improvisation, consciousness corridor, still image)

Materials: Paper, pen, calculator, proper music song

Pre-requisite: Having knowledge about measures of central tendency

Objectives:

➢ Finds and interprets measures of central tendency belonging to a data group.

➢ Creates and interprets graphs.

➢ Develops a strategy to solve a mathematical problem.

Drama Process:

Preparation/Warm-up

1st Activity: (Amusement park instruments) (15 minutes)

Participants form a circle. Five groups are formed by counting to 5 consecutively. The teacher asks the participants, in small groups, to animate an instrument in the amusement park with motions and sounds. First, all the groups enact in turn, then all the groups enact simultaneously (with the accompaniment of proper music song).

Interim evaluation: Participants perform their animations in order. The teacher guides the process by asking question "Which instrument it is?", "What is your opinion?" and participants try to find out animated instrument.

Role Play/Improvisations

2 nd Activity: (Amusement park peddlers) (15 minutes)

The participants roam freely in the area. The teacher says, "*This is an amusement park and you are a peddler working in this park. Choose a role and product for yourself and now sell that product with a slogan in that role.*" All the participants improvise simultaneously. The participants become still images with the instruction of the instructor. The teacher randomly touches the shoulders of the participants and asks them to act out their roles (with the accompaniment of proper music song). All the participants act out, in turn.

3rd Activity: (Amusement park peddlers and business owner) (60 minutes)

The teacher in his role and says; "*Dear employees, as you know, I started this business in this amusement park last summer. You are travelling around the park and selling popcorn, ice cream, boiled corn, nuts, toys and fruit juices. We had a very good season last year thanks to your efforts. There has been a serious decrease in the number of customers coming to our park this summer. We are having a hard time paying your salaries and striving to survive the business. A total of 18 people work in the sale of six different products. This year, I will continue on my way with 12 employees who will work in the sale of only 4 products in the park. I'm having a hard time deciding which products to abolish and who to lay off. All I want is to be fair and not to offend anyone. I'm asking you to defend yourself that I shouldn't fire you. Now you have the word*".

Each group gives a name to the business owner. Participants improvising in the same peddler role from the previous event come together and act out one after the other with justifications to defend themselves (The trainer makes an arrangement in such a way that the peddlers mentioned in Table 1 are in the role).

The teacher is in the role again and says *"I have listened to all. My accountant analyzed last year's records and tabulated the revenue from the sale of each product group according to how crowded the park is. As you know, we tried to determine a tendency by asking children visiting the park "What product would you most like to buy?" I want to make the right decision for the business"* and thus asks the groups to examine the data and wants to make his decisions on more scientific grounds.

Calculators, table1, table 2, paper and pencils are distributed to the participants. They are given time to rethink the data.

Table 1. Revenue Created for the Business Last Year (Turkish Lira)

How crowded the park is Product Group	JUNE			July			August		
	Very	*Moderately*	*Little*	*Very*	*Moderately*	*Little*	*Very*	*Moderately*	*Little*
Popcorn	1600	780	252	699	758	835	1788	1732	1462
Ice cream	1074	874	906	4612	2032	477	4500	3534	2712
Boiled corn	1047	667	184	1389	804	450	1862	1006	950
Nuts	1263	1188	765	1584	1468	149	1900	1276	1158

| Toys | 1264 | 1172 | 300 | 2477 | 681 | 548 | 2000 | 1130 | 950 |
| Fruit juices | 1115 | 878 | 574 | 2972 | 2399 | 231 | 1822 | 1594 | 577 |

Table 2. Results of the Survey Conducted Last Year

Answers to the question "Which one would you like to buy most in the park?"	
Popcorn	452 (n=2200)
Ice cream	561 (n=2200)
Boiled corn	358 (n=2200)
Nuts	340 (n=2200)
Toys	523 (n=2200)
Fruit juices	429 (n=2200)

After the participants work on the data in groups, the teacher is in the role again and says "*now it is the time to decide*" and listens to the peddler groups' arguments.

After listening to the arguments, the business owner tries to make a decision.

Interim evaluation: The teacher guides the process by asking questions; "*Which justifications emerged in the process? Which product group should be discontinued this year on the basis of these justifications?, Would the owner of the park act fairly?, Which product group should be discontinued when we use scientific methods? What methods did you use during this process*?"

Reflection and Evaluation (30 minutes)

For the evaluation process, the teacher asks the participants to fill in the reflective forms prepared for the process. Following questions are placed in the form.

➢ Explain your solution in detail.

➢ What are the statistical concepts that you think about/use in the process and in solving the problem?

➢ Where and how did you use these concepts to work? Please explain in detail.

➢ Briefly describe these concepts.

➢ Why did you prefer to use these concepts? Please explain in detail.

➢ Explain why you did not use some concepts related to measures of central tendency.

➢ Did you use graphs? Why and which one?

➢ What are your general views on the process?

➢ What are the stages that you followed easily in the process? Explain why.

➢ What are the stages in the process that you have difficulty with? Explain why.

➢ Explain the importance of scientific methods.

A class discussion is made together and a general evaluation is made on the filled form.

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About the Authors

Zeynep Sonay Ay is an assistant professor of Mathematics and Science Education at Hacettepe University in Ankara, Turkey. She has studies on creative drama, problem solving, reasoning, modeling in mathematics education. Email: sonayp@gmail.com

Seyda Aydın is a research assistant at Hacettepe University Faculty of Education.She received her master's degree from Hacettepe University in Ankara, Turkey. Her research interests include mathematics education and gifted education.

Email:seydaaydin@hacettepe.edu.tr

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Mathematical Patterns

Hakan Yaman
University of Bolu Abant Izzet Baysal

Introduction

Mathematics is a scientific field which has implementations in science, technology, in all other sciences and in the real world, and most of the time it is called as a science of patterns; it is not just the numbers and processes done with them. Mathematics is a tool which is used in understanding environment, solving problems, being creative and expressing things that cannot be seen otherwise. In a sunflower, in a leopard speckle, in the flow of water, in a golf course, in the rolling of a dice, in the living time of a star, in the shape of the world, in the pace of a runner, in weather forecasting, in a computer's processing, there is always a pattern. It can also be said that, in daily life, there is always mathematical relations in nature (Devlin, 1998). Understanding these relations and finding rules between these relations enters the field of algebra, which is one of the sub-branches of mathematics.

NCTM (2000) suggests that it is important to develop a different educational approach in algebra teaching known as a difficult area for children. Traditionally, algebra is introduced to the students at the end of primary education and in the early secondary education. Due to the abstract nature of algebra (Orton and Orton, 1999), this new information is seen as a completely compelling mathematical field by the students (Willoughby, 1997). As a result, it is seen that the thoughts on algebra education are changed. Researchers and Educators suggest that the natural development in algebra should be presented more gradually (Fouche, 1997, Willoughby, 1997). To do this, they state that it is needed to include algebraic concepts in primary education programs (Yackel, 1997; Orton and Orton, 1999).

Researchs supports NCTM striving for algebra education in an earlier period. Schliemann, Goodrow and Lara-Roth (2001) indicate that an education in which algebraic concepts presented in a concrete form first, then gradually the more abstract concepts chosen and later abstract representations are given can be better understood by primary students. Yackel (1997) describes that it is not meaningful to present quadratic formulas by abstract concepts to the primary school students when introducing algebra. Algebra includes reasoning and thinking strategies that help modelling, find patterns, and work with structures rather than just solving linear equations. Students need more than just thinking numerically. They also need to explain the ways to use the relationships and symbols between numbers (Yackel, 1997). Fouche (1997) states that to make algebra

more beneficial, how to generalize the rules must be taught rather than memorizing them. Therefore, pattern and generalization concepts are seen as one of the most important issues of algebra.

Patterns, relations between patterns and generalization of patterns constitute the basis of algebraic thinking. In other words, students' ability to think algebraically is due to the recognition of the patterns, continuing of patterns and generalization (Smith, 2003; as cited in Steele, 2005, p. 142). Zaskis and Liljedahl (2002, p. 379), in mathematics, especially in the algebra, indicate that all concepts are related to the patterns and generalization of patterns. For this reason, many educators and researchers say that patterns and generalization of patterns are the heart and essence of mathematics.

Many philosophers, mathematicians and mathematical educators believe that patterns are a very important concept in learning and teaching of mathematics (Davis, 1984; Mottershead, 1985; National Council of Teachers of Mathematics, 2000). NCTM, while stating the program and evaluation standards of school mathematics, states that there are patterns all over the world, and therefore, the mathematical curriculums should help students deal with the mathematical models or definitions of these patterns (NCTM, 1989).

Both patterns and generalization concepts are considered the basis of mathematics. Therefore, these concepts are also very important for mathematics education. The importance of generalizing about the pattern is particularly emphasized. Because the structure of mathematics can be observed by means of searching patterns and relationships. These patterns and relationships become understandable, usable and expressible by generalizations about them. Thus, the patterns that can be expressed or sustained are gaining an important value for the passage to formal algebra (NCTM, 2000).

Schoenfeld and Arcavi (1988, p. 426) expressed that students' observing patterns and expressing them verbally will help the transition from arithmetic to algebra. According to them, the children who are engaged in the patterns begin to seek a regularity and relationship, and the generalizations they found encourage them in algebra. For Jones (1993, s.27), generalization is the heart of algebra and seeking patterns is an important step towards generalization.

The current studies in the context of early algebra education are investigating students' ability of generalization and whether students can find the rules in growing numerical patterns such as linear generalization problems (Stacey, 1989; Looney, 2004, Tanışlı, 2008). It is also stated that these subjects will constitute a strong basis for subsequent algebra learning (Kenney and Silver, 1997, Orton and Orton, 1999; Lannin, 2003; Schliemann, Caraher, Brizuela, Earnest, Goodrow, Lara-Roth and Peled, 2003; Ferrini -Mundy, Lappan and Philips, 1997). Schultz (1991) claim that early student's ability

to develop more formal mathematical concepts should be based on their informal understanding of the pattern. Ferrini-Mundy et al. (1997) suggest that pattern activities can help students show relations, think about these relations and identify these relations. "Patterns, Relations and Functions" is located as one of the NCTM's algebra standards (2000). NCTM (2000) suggests that in order for students to generalize geometric and numerical patterns in a more complex manner, in order to show patterns and functions verbally, or as table and graphics; It recommends that students should participate in pattern activities from the young age.

As a result, the concepts of pattern and generalization are very important in mathematics education. In particular, in terms of the basis of algebra education, they must have experiences with the pattern and generalization at an early age and learn these issues. Students who have learned patterns and generalization at an early age will not have problems when they encounter abstract symbols, notations, and rules in algebra education. Based on here, it is important to define what pattern and generalization means; since they have a very important place in mathematics, especially in the algebra.

Pattern and Generalization Concept: Current Use and Mathematical Language

The concept of pattern is not found in the old math programs applied in Turkey. This concept is used for the first time in the renewed math program in 2004. Therefore, the "pattern" is not a very well-known and used word in the daily language. The concepts of "pattern" and "generalization" are described in the Turkish Language Association Dictionary and the Oxford Dictionary:

Pattern: The development of events or objects in an orderly way following each other. For example, the days of the week constitute a pattern (www.tdk.gov.tr).

Pattern: (1) The regular way in which something happens or is done.

(2) Pattern for something an excellent example to copy.

(3) A regular arrangement of lines, shapes, colours, etc. for example as a design on material, carpets, etc.

(4) A design, set of instructions or shape to cut around that you use in order to make something.

(5) A small piece of material, paper, etc. that helps you choose the design of something (www.oxfordlearnersdictionaries.com).

Generalization: To collect, circulate, determine similarity relations between assets or events in one thought (www.tdk.gov.tr).

Generalization: A general statement that is based on only a few facts or examples; the act of making such statements (www.oxfordlearnersdictionaries.com).

When the "pattern" and "Generalization" concepts are referred to by mathematically, a series of patterns, which can be modeled by a mathematical function, orderly sequenced, an object, a shape or numbers are called as pattern, and finding the mathematical function in this sequence of numbers as a generalization. There are also many definitions of mathematicians and mathematics educators related to the pattern.

> *Regularly lined, poem formed by recurring objects or shapes (Olkun and Toluk* Uçar, 2009, p. *120).*

> *A numerical or spatial regularity (Papic and Mulligan, 2005, p. 609).*

As mentioned earlier, the pattern is in all areas of life. Due to these patterns in daily life and the environment, children are naturally predisposed to generalize. Deloache, Miller and Pierroutsakos (1998) indicates that children try to use patterns and generalization.

Historical Development of Pattern Concept

Although there is no information on the historical development of the pattern concept, it is stated that the concept of patterns originated with the emergence of the number theory (Ore, 1948; as cited in Beougher, 1971). It is said that the most important of the groups related to the emergence of number theory is a group consisting of ancient Greek mathematicians known as Pythagoreans. This group consists of students who benefit from Pythagoras' teachings in a school, established by Pythagoras who gave his name to a famous formula in geometry (550 BC). Number patterns are also seen as one of the most important parts of the number theory. Some of these patterns were found by Pythagoreans and they provided names such as friendly-amicable numbers, excessive numbers, deficient numbers, and perfect numbers. For example, divisors of the numbers 1184 and 1210, excluding 1184 and 1210, are as follows.

The sum of the divisors of 1184 from these numbers 1210, and the sum of the divisors of 1210 gives the number of 1184. Based on here, the Pythagoreans have made the name of this type friendly-amicable numbers.

Likewise, the divisors of 6, 8 and 12 others than themselves are seen in Table 1.

Table 1. Examples of Perfect, Excessive and Deficient Numbers

	Number	Divisors	Sum of Divisors
Perfect Numbers	28	1, 2, 4, 7, 14	$1+2+4+7+14 = 28$ $(28 = 28)$
Excessive Numbers	12	1, 2, 3, 4, 6	$1+2+3+4+6 = 16$ $(12 < 16)$
Deficient Numbers	15	1, 3, 5	$1+3+5 = 9$ $(15 > 9)$

According to Table 1, the number 28 is obtained when the divisors of 28 added. These types of numbers were called as the perfect numbers by Pythagoreans. Even because the first perfect number is 6, they claimed that God created the world in 6 days. Similarly, since the sum of the divisors of the number 12 is greater than 12, these types of numbers were called excessive numbers, and as the sum of the divisors of the number 15 is less than 15, this type of numbers were called deficient numbers.

In addition to such patterns, the Pythagoreans have shown the numbers with points and the geometric configurations of those numbers.
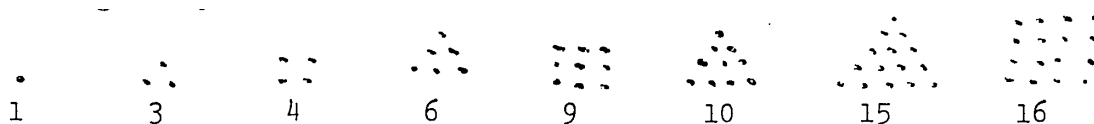
Figure 1. Displays of Triangular and Quadrants

As seen in Figure 1, the Pythagoreans also showed patterns via shapes. Numbers such as 1, 4, 9, 16 were called quadrant numbers; and numbers such as 1, 3, 6, 10, 15 were called as triangular numbers. After that time, many new patterns were uncovered with the development of algebra. Eratestones (230 BC) revealed prime numbers, Fibonacci revealed a pattern named after him, and Gauss revealed a pattern related to the total of sequential numbers (Ore, 1948; as cited in Beougher, 1971).

Types of Patterns

Primary-age students have two types of patterns to discover. One of them is repeating patterns and the other is the growing patterns (Warren and Cooper, 2006). Mostly these patterns are used in finding generalizations within their elements. In this type of patterns, answer is sought for questions such as "What comes next? What is the repeating part? What are the missing elements? " These primary level activities are considered as finding the pattern in a data set that mostly shows a single change (Blanton and Kaput, 2004). Repeating and growing patterns lead to the functional thinking of students in early ages and help them better understand the relationships between the two data sets.

Repeating Patterns

Recurrent patterns are the continuous self-repetitions of a group of elements. These types of patterns have a repeat unit (Papic, 2007). Liljedahl (2004) states that it has a circular structure in which a small part of the repeating patterns can be generalized by repeating a small unit of a pattern again and again. He also stated that this small unit may change due to features like size, shape, magnitude, and direction, and called this part as pattern repeat unit, element, portion or part.

For example;

∇ ∇ ∇ ∇… pattern where ∇ is the repeat unit

←↑↓→←↑↓→←↑↓→… pattern where ←↑↓→ is the repeat unit etc.

Various impressions are used in such patterns in different forms. For example ∇ ∇ ∇ pattern with geometric shapes, can be represented with movements such as "Sit down, get up, sit, get up, sit, get up", with sounds such as "drum tone, ringtone, drum tone, ringtone, drum tone, ringtone"; with letters such as "ababab" or with feelings such as "smooth, rough, smooth, rough, smooth, rough, smooth, rough". There is a sequence that students will follow when looking for a repeating pattern:

1. Copying the pattern: In the first phase students can be given a pattern as follows and be asked to copy this pattern.
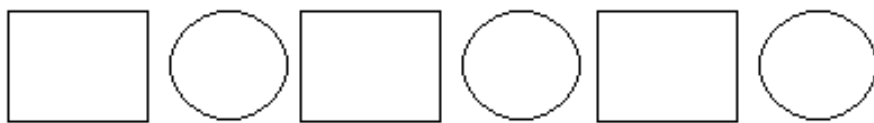
2. Continuing the pattern: In this stage, the following type of questions can be asked to ensure that children are realizing the repeating pattern. "What shape comes after the hoop? Which shape comes before the quadrangle? ". Then, the students may be asked to extend the pattern on both sides.
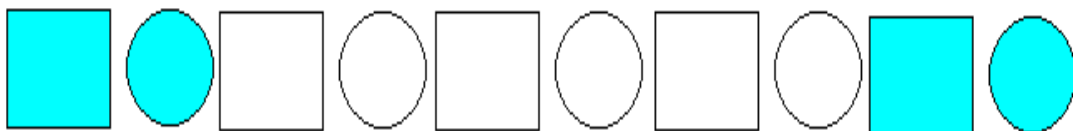
3. Identifying the repeating element: At this stage, the pattern can be uttered loudly (quadrangle, circle, quadrangle, circle, quadrangle, circle) and repeat unit can be asked to students. Then they may also be asked to encircle the repeat unit with a piece of rope.
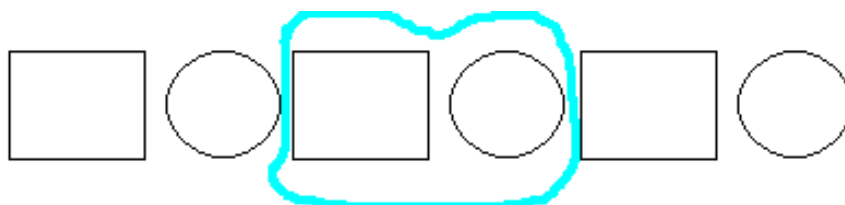
4. Pattern Completion: A repeating pattern can be created, and children can be asked to continue the pattern and determine the repeating element. Here, some elements of the formed pattern can be removed by wanting children to close their eyes. When children turn their eyes again, they can be asked what element is removed.

5. Creating a pattern: At this stage, children may be asked to form their repeating patterns. After they have created them "Why is this a repeating pattern? Will you show me the repeating part? How does this pattern continue?" etc. questions can be asked.

6. Transferring a pattern to a different environment: This process is very important at all levels of mathematics. This stage can help children in small age developing their common and different aspects in developing different representations. These differences are generally superficial differences. For example, sit down, get up, sit down, get up instead of triangle, square, triangle, square use etc. The partnerships are related to the structuralism of the mathematics. For example, the pattern consists of two elements and an element is continuously follows the other etc. (Warren and Cooper, 2006).

Papic (2007) says that repeating patterns can be discussed in 3 parts, in the form of linear, cyclical and hopscotch. He states that repeating patterns are mostly presented in a linear form like a flat line, and that linear repeating patterns may extend forever in accordance with different instructions. Simple repetitions such as "Abababab" are one of the typical samples of linear repeating patterns and the elements of such patterns can be presented vertically, horizontally, or diagonally. The first or end point of cyclic repeating patterns are not exactly clear. Day-night, seasons or the limit of patterns generated at the edge of a polygonal region and simply repeats can be shown in this type of pattern (see Figure 2.a). Hopscotch patterns are used to investigate the children's abilities of repeating units of squares to rotate horizontally and vertically. Such tasks are investigating how students see the changes in the direction of the pattern and their transformation related skills (see Figure 2.b) (Papic, 2007).
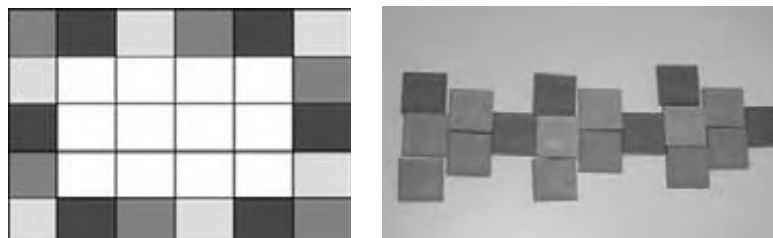

Figure 2. Cyclical and Hopscotch Repeating Pattern Examples

Growing (Changing) Patterns

Growing patterns are also known as numerically increasing or decreasing patterns. Growing patterns are the patterns that are followed by an expanding or shrinking course

of relations between terms (Olkun and Yeşildere, 2007, p. 13). Each term in such patterns connected to each other with a rule. In such patterns, a generalization or an algebraic relationship is searched next to continuing the pattern (Tanışlı and Olkun, 2009, p. 11). In addition, it is stated that the growing patterns can be considered as a starting point in the concept of generalization, equation and function and algebraic thinking (Van De Walle, 2004). Growing patterns are grouped in four different ways (Tanışlı and Olkun, 2009, p. 11).

Arithmetically Growing Patterns: A follow-up of each term is obtained by adding a constant number is called an arithmetically growing pattern. The rule or relationship of the pattern may be explained by a linear equation. Therefore, it is also called linear growing patterns. An example of arithmetic growing ing patterns is given Figure 3.
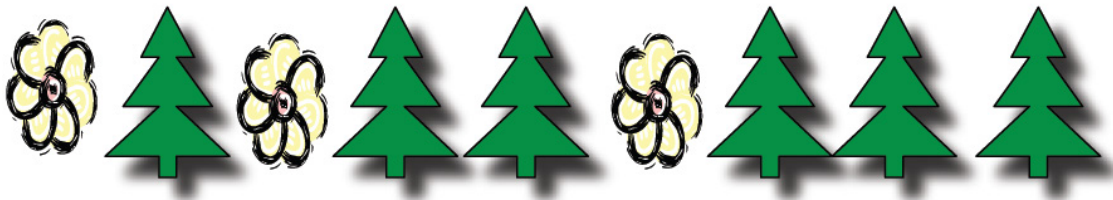

Figure 3. Arithmetically Growing Pattern Sample

The step of the pattern is called the range where the pattern shows similar change (Olkun and Yeşildere, 2007, p. 13). There is a flower and a tree in each step of the pattern in the sample. However, as the steps increase, an extra tree is added to each step. As given in the example, arithmetically growing patterns can be presented in shape, and they can also be presented in the form of numbers, table and verbal problem.

Geometrically Growing Patterns: The patterns in which successive pattern elements change within a ratio are called geometrically growing patterns. The rule or relationship in such patterns may be explained by the exponential equations. For example, for the n term of a pattern whose terms a_1, $a^1.r$, $a_1.r^2$, $a_1.r^3$, $a_1.r^4$, …; if the rate of the first term and the two consecutive terms are a_1, $a_n = a_1.r^{n-1}$ rule can be used. An example of geometrically growing patterns is given Figure 4.

Input	Output
1	2
2	6
3	18
4	54
5	162
…	…
n	2.3^{n-1}

Figure 4. Geometrically Growing Pattern Sample

The pattern in the sample is given outputs for each input. As the inputs progress, there is always a 3-times rate between the output numbers. For this reason, the elements of the pattern continue as $2, 2.3, 2.3^2, 2.3^3, 2.3^4, \ldots$ This sample is presented in the pattern table format. In addition to this presentation, the geometrically growing patterns can be presented in the form of numbers, shape, and verbal problem.

Increasingly Growing Patterns: Patterns in which the differences between the successive terms increase or decrease are called increasingly expanding patterns. There are no fixed differences between terms in such patterns. However, when discrepancies between the differences are viewed, fixed differences are achieved in step 2 or 3. In addition, the rules of such patterns can be explained by the second or third order equations. For example; providing a, b and c are fixed and a_n is the n term, the rules of such patterns can be expressed in the form of $a_n = a.n^2 + b.n + c$ or $a_n = a.n^3 + b.n^2 + c.n + d$. The rule is also called quadratic growing patterns which can be expressed in a quadratic equation. A sample is given to growing patterns increased in Figure 5.
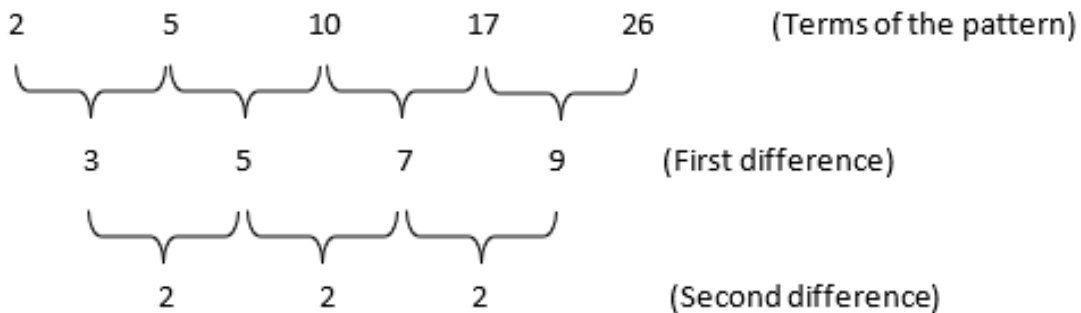

Figure 5. Growing Pattern Sample by Increasingly

The difference between the terms of the pattern in the sample is not a constant number. The differences between terms are 3, 5, 7, 9, ... However, it is seen that the difference between each difference is 2. This shows that the rule of the pattern can be expressed in a quadratic equation. In other words, this example of pattern is also a quadratic growing pattern. Provided that a_n is the nth term, the rule of the pattern is in the form of $a_n = n^2 + 1$. This pattern is presented in the form of number sequence. In addition to this presentation form, growing patterns can be presented in the form of table, shape, and verbal problem.

Other Patterns: There are also patterns that do not belong to the class of arithmetic, geometric and increasingly expanding patterns, but whose terms change in a regularly. Fibonacci numbers, a very famous number sequence, and the Pascal triangle are examples of this type of pattern. A sample is given to other patterns in Figure 6.

A pair of rabbits (one male, one female) is put in the corral. Two months later, these rabbits have one male and one female offspring. After that, a couple will have offspring every month. This pattern continues: after two months each rabbit pair has a pair of offspring, and every month thereafter an additional pair of offspring. How many pairs there will be at the end of a year?

Figure 6. An Example of Other Type of Pattern

This pattern is called Fibonacci pattern. The terms of this pattern are obtained by adding the two previous numbers. This pattern does not correspond to an arithmetic pattern; it is also neither a geometric nor a growing pattern. The solution of the pattern presented above as a verbal problem is given in the table below (see Figure 7).

| Ay	Tavsan Çiftleri	
1	1	
2	1	
3	2	After two months, the first couple has two offspring.
4	3	The first couple has two offspring for the second time.
5	5	The first offspring will have two offspring.
6	8	And so it continues.
7	13	And so it continues.
8	21	
9	34	
10	55	
11	89	
12	144	

Figure 7. Solution of Fibonacci Pattern

According to this, 144 rabbits pair will be formed at the end of 12 months. The terms of this pattern are in the form of 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ... As in the case of such patterns, it can be presented in the form of verbal problem, in the form of a table, shape and number series (Olkun and Yeşildere, 2007, p. 13-20; p. 11-16). Therefore, these presentation forms are described, and the examples of these presentations are given in the next section.

Presentation Formats of Pattern

Types of patterns are examined in two main categories, repeating, and growing as described above. In addition, there are different forms of presentations to present any type of patterns. These presentation formats can be mentioned in different forms such as shape (visual), table or graphics, number sequences and verbal problems.

Patterns Presented in Shape (Visual) Format

The patterns presented in shape can be in the form of an increasing series of dots, in the form of shapes from matchsticks or toothpicks, shapes from unit squares or the patterns formed from blocks or tiles (Ley, 2005). In addition, shape patterns of real-world objects such as flowers, tree or geometric shapes can also be created (see Figure 3). The question in Figure 8 in TIMMS can be given as an example of the patterns presented in shape form.
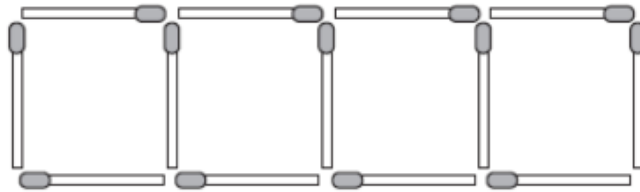
13 matchsticks have been used in order to form the 4 squares in the figure. By using the same method how many squares can be formed by using 73 matchsticks?

Show your calculations used for finding the answer.

Answer: ……………………………………

Figure 8. A Pattern Question Presented in TIMMS

The patterns presented in concrete and visual form are seen easily than symbolically presented patterns. Bruner (1966), also, states that the orderly use of concrete, visual and symbolic stages in new learning will provide students with convenience. The aim of the shape patterns is to support students by thinking with visual approaches and to find an alternative way to numbers. Another goal of figure patterns is to diversify the ways of problem solving. It is also stated that the figure patterns can make students make changes when necessary and to help them create a new step from one step. It is also said that shape patterns are more fun than other forms of presentation for students (Orton, Orton and Roper, 1999, p. 122).

Figure patterns can be formed from the dots, can be formed from unit squares, and tiles. Figure 9 shows an example of a linear expanding pattern created with unit squares.
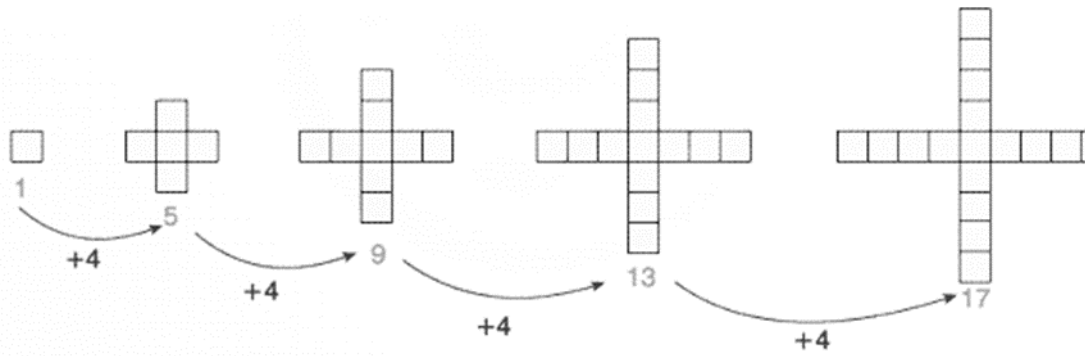
Figure 9. A Pattern Presented in the Form of Linear Expanding and Shape

This pattern has started with a square and is a shape pattern that has continued by adding a square to 4 sides on other steps. When finding the pattern, it is necessary to determine how many squares in each step first. Then, the differences between the number of square numbers in each step should be examined and whether the difference changes or not. The difference between the square numbers in each step in this pattern is constant and 4. Therefore, this pattern is a linear expanding pattern, and the rule of the pattern is a_n and n^{th} term is in the form of an = 4n-3.

Patterns Presented in Table or Graphics Format

Another form of presenting patterns is the presentation in the form of table. An example of this type is seen in Figure 10. In this pattern question, there is a table in which the value column B changed according to the value in column A. In such tables, students are required to find the relationship between the number in column A and the number in column B.

Çalının boyu (cm)	Gölge boyu (cm)
20	16
40	32
60	48
80	64

Yukarıdaki çizelge, farklı boylardaki dört çalının sabah saat 10:00'daki gölge boylarını göstermektedir. 50 cm boyundaki bir çalının sabah saat 10:00'daki gölge boyu nedir?

Ⓐ 36 cm

Ⓑ 38 cm

Ⓒ 40 cm

Ⓓ 42 cm

Bush height (cm)	Shadow length (cm)
20	16
40	32
60	48
80	64

The table shows shadow lengths of four bushes of differeing heights at 10.00 A.M. What is the shadow length of a 50 cm bush at 10.00 A.M.?

A) 36 cm

B) 38 cm

C) 40 cm

D) 42 cm

Figure 10. A Pattern Question Presented in TIMMS

It is stated that the table presentation form plays a critical role in a pattern search processes

through the outputs that students can systematically record in each row (Schliemann, Carraher and Brizuella, 2001). On the other hand, researchers such as English and Warren (1998) state that especially in the understanding the concept of variable, it is very important to make generalizing from the data tables. In addition, some researchers also reveal the benefits of the table form presentation in the understanding of students in particular linear functions and seeing functional relations (Schliemann, Carraher and Brizuella, 2001; Martinez and Brizuella, 2006). It is also said that it can help students to understand the value of the table when defining a pattern (Pegg and Redden, 1990).

In the patterns presented in the table format, the first column consists of the inputs and the second column consists of outputs of these inputs. In Figure 11 a pattern which is presented in the form of table and expanding quadradically is given.

Figure 11. A Sample of Pattern Presented Table Format and Expanding Quadratically

In the above pattern, the number of inputs is 1, while the output number is 0, and while the number of inputs was 2, the number of outputs was 3 and the pattern continues this way. Looking at the differences between the output numbers, it seems that the differences are not constant, and they change. Therefore, it can be mentioned that this pattern is an increasingly expanding pattern. When we look at the difference of differences, it is seen that there is a constant difference of 2. Therefore, it can be said that this pattern is a pattern whose rule can be expressed by a quadratic equation. The rule of the pattern is $a_n=n^2-1$ provided that a_n is the nth term.

The Patterns Presented in the Form of Numbers

Another form of presenting patterns is number sequences. These are also named as skip counting. Generally, patterns are presented in this form in mathematics textbooks. In this presentation format students are required to determine the relationships between the terms given and to write the numbers of which are not given. It is also expected students to express the rule of the pattern based on the relationship they found (Ley, 2005). The terms of these types of patterns can be presented from left to right by issuing a comma or with a certain amount of space. An example of this presentation can be given as follows.

$$8 \qquad 14 \qquad 20 \qquad 26 \qquad 32 \qquad ... \qquad ...$$

In this sequence, the first 5 terms are given, and students are required to find the two terms coming afterwards. Then, in order to find the nth term, students are expected to find a rule. In this presentation format, it should be ensured that the space between the terms are equal in the patterns. Because the numbers arranged at different distance may confuse students. For example, when the terms of the Fibonacci sequenced as follows students will experience great problems at catching this pattern (Burke and Orton, 1999).

$$1, \qquad 1, \qquad 2, \qquad 3, \qquad 5, \qquad 8, \qquad 13, \qquad ...$$

This kind of number sequence patterns may cause students to have problems in finding the relationships between terms. Therefore, the patterns of the number sequence are also presented as follows.

1. adım: 8

2. adım: 8   14

3. adım: 8   14   20

4. adım: 8   14   20   26

5. adım: 8   14   20   26   32

In this type of patterns, students can find the rule of the pattern by relating to the number of steps with the last number in that step. For example, in this pattern, the last number in step 1 is 8, the last number in the second step is 14, the last number in step 3 is 20, the last number in step 4 is 22 and the last number in step 5 is 32. In view of the number of steps and the last number, it is seen that the last number 6 more than 2 times of the number of steps. Based on here, the rule of this pattern is $a_n = 2n + 6$.

The Patterns Presented in the Form of Verbal Problem

The patterns may be presented in the form of verbal problems or stories. One of the best-known problems in this type is the problem of "handshake" (Burns, 2000; Van De Walle, 2004).

> *If 2 people in a group handshake each other, it counts 1 time. If you have 3 people in the group, they handshake 3 times among themselves. How many handshakes will there be if there are 4 people in the group? How many handshakes will you have if there are 6 people in the group?*

Another example of this presentation style is presented below (Figure 12).

You have a rope and we cut it in the form "U". We do it repetitively for the rest of the rope. Accordingly;

1. How many pieces are formed when the rope has been cut once, twice, and three times?

How many pieces are formed when the rope has been cut 4 and 8 times?

2. Could you find a rule between the cut times and number of pieces? Express your answer verbally.

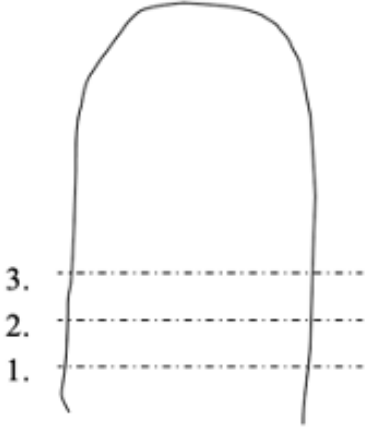3. Can you form a symbolic rule if we name number of cuts as "K" and number of pieces as "P"?

P=

Figure 12. Number of Cuts Problem

Conclusion

NCTM recognized the importance of a different educational approach to teaching algebra. Because this field is very difficult for students. Traditionally, algebra is given to students in the 6-8. grades or high school ages. Despite the abstract nature of algebra, this sudden knowledge has been expressed as a complete struggle for students (Willoughby, 1997).

As a result, there has been a recent change in thinking about algebra education. Researchers and educators today suggest a more stepped and natural developmental education in algebra (Fouche, 1997; Willoughby, 1997). It is stated that such an education will only be possible if algebraic concepts are introduced gradually from the first years of primary education (Yackel, 1997; Orton & Orton, 1999).

Algebra education, which started in the 7th grade in Turkey, started in the first years of primary education with the Primary Education Mathematics Curriculum changed in 2004, and this process continued in the Mathematics Curriculum changes made in the following years. In particular, the subject of "Pattern and Tessellations" was placed in the first years of primary education, where it was aimed that students go to the algebra subjects in the future with a better foundation by generalizing and searching for relationships in patterns. In this context, besides what the concept of pattern is, the necessity of using pattern types and different presentation styles in lessons for different grade levels has emerged. Because in the studies conducted, it has been observed that students achieve different levels of success in different pattern types or different pattern presentation styles (Pegg & Redden, 1990; MacGregor & Stacey, 1993, 1995; English & Warren, 1998; Dobrynina, 2001; Lannin, 2003; Tsankova, 2003; Looney, 2004; Tanışlı, 2008; Yaman & Umay, 2013). In order to minimize these differences, it is necessary to

ensure that students work with all pattern types and pattern presentation styles. Because the better the children are in patterns and relationships at this age, the more solidly they will move to algebra in the following years.

Acknowledgements or Notes

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About the Authors

Dr. Hakan Yaman is an Associate Professor in Faculty of Education at the University of Bolu Abant Izzet Baysal, Turkey. He has studies on algebra education, and patterns. He also has an increased interest in interdisciplinary studies and has projects on brain research and eye tracking research. Email: hakanyaman@ibu.edu.tr, ORCID iD: https://orcid.org/0000-0001-8007-8198, ResearchGate: https://www.researchgate.net/profile/Hakan-Yaman-2,

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SECTION 5
ASSESSMENT IN EDUCATION

Alternative Assessment Methods in Primary Education: Review and Future Directions

Mehmet DEMIR
The University of Birmingham

Introduction

New insights within the knowledge age, where change is constant and unpredictable and also the skill to accomplish difficult tasks is more likely to rely on one's ability to navigate the vast array of informational resources than it's to base on static knowledge have resulted during a shift in education and assessment. Learning theories such as constructivism, multiple intelligences, and project-based learning have deeply affected traditional teaching, learning, and assessment theories in addition as their applications. One in all the explanations for the evaluation and improvement of teaching, and learning theories is that the meaning and therefore the scope of the definition of learning have shifted. This shift involves a unique approach to each stage of learning and teaching process, including a brand new approach to assessment.

Learning is a life-long process, which successively makes instruction more student-directed. This involves students who have better problem solving, critical thinking, synthesis, analysis, moreover creativity to achieve success. Additionally, student's ability to gauge has increased; this, in turn, demands alternative styles of assessment to assess both learning process and outcomes.

In recent decades, there has been a big change within the selection and usage of tools for assessment within the learning process. The paradigm of assessment in schools, colleges, and universities has been shifted from traditional methods to alternative routes and that they are relying less and fewer on traditional paper-and-pencil tests and developing creative ways to assess the training of their students. Traditional methods merely evaluated students with a teacher-centric approach that was largely opaque to students. Newer approaches to assessment don't simply determine whether a student knows something or not; ideally, the assessment reveals much deeper aspects of the educational process and may enable students to elucidate, apply, critique, and be self-monitored.

In response to requirements for reformed assessment, alternative assessment methods have acquire play. Thus, alternative assessment methods should be used rather than traditional assessment for providing every student with the simplest learning opportunity if we truly believe inclusion and variety, which builds on the understanding that everybody is capable of learning and deserve the most effective possible investment in his or her

education, it becomes unsustainable to continue using an assessment model that has traditionally developed to specialize in selection, certification, and accountability.

Literature Review of Alternative Assessment Methods

What constitutes of Alternative Assessment?

Before providing the definition of alternative assessment, there needs to be stressed that the terms "complementary and alternative" are interchangeably used in measurement and assessment. That is, it is preferred 'complementary' term to 'alternative' one some research. However, the use of the "complementary" term is quite new for related literature under investigation. For this reason, we deployed an 'alternative' term to access much more papers in this study.

Alternative assessment can be described as "performance assessment", "direct assessment" and "authentic assessment" (Culbertson, 2000, p. 32). Students are evaluated with a variety of methods such as project-based assignments, peer assessment, self-assessment, portfolios, performance-based tasks, rubrics, and other types of open-ended approaches. The concept of alternative assessment was developed as a consequence of teachers' dissatisfaction with the lack of tools to show students' actual improvement and strengths. Alternative assessments aim to provide complex assessments and multiple, rich evaluations. These methods also provide rich, realistic information about students' achievement, encourages their active participation, and holds them to high expectations for in-depth understandings of challenging academic content.

Alternative assessment, which serves as a supplementary component for students who have different learning styles, gives students a way to construct their answers in a way that traditional assessment does not. Alternative assessment emphasized opportunities for teachers to foster students' reasoning and critical thinking, create their own solutions for complex problems, and present their own perspectives using multiple presentation methods for daily life problems. In addition, these assessment methods way help students become more discerning and innovative and help them determine what they have learned and what they still need to learn by enabling them to use and assess their pre-existing knowledge and skills more effectively.

Alternative Assessment Methods

Alternative assessment (AA) is an umbrella term for a variety of nontraditional assessment methods, including classroom-based, informal performance assessment and authentic assessment, portfolio assessment, and project-based assignments. AA is based on a constructivist view of learning; viewing learners as active constructors of knowledge and supplying responses rather than selecting or choosing. Therefore,

alternative assessment has the potential both to reverse student passivity, replacing it with initiative, self-discipline, and choice, and to promote compassion, vision, trust, and spontaneity in students. AA was developed "as a result of lacking tools that can show students' real improvement and their strong strides, and the dissatisfaction of implementers about prevalent assessment tests" (Balliro, 1993).

The traditional way of assessment is not really efficient for many reasons and it focuses on students' knowledge and skills, however, AA focuses on students' learning strategies, problem-solving, and task completion, using direct and holistic measurements of what students know. Moreover, alternative assessment uses activities that discover "what students are able to do with the knowledge and skills obtained through learning", emphasizing their abilities and strengths instead of focusing on their weaknesses and what they do not know (Oliver, 2015).

Alternative assessment actively requires students to participate in the process of "what is taught, how it is taught, and how it is evaluated" (Kreisman, Knoll, & Melchior, 1995, p. 114). Therefore, over the past two decades, numerous studies have been conducted to examine alternative assessment methods on teaching and student learning in primary education. Thus, the purpose of this book chapter is to focus on Alternative assessment methods in primary education curriculum to define the general characteristics of alternative assessment methods, provide a broader perspective of alternative assessment information, and in this way, it can attain a conceptual framework to enhance and improve the knowledge of alternatives methods to best accomplish an informative review for researcher and teachers. Because the AA methods are the primary factor in determining what students understand, as well as what and how they are learning; whether or not they have accomplished the learning goals. Furthermore, it provides teachers an insight into the success of teaching strategies and students' preference of learning styles. This focus on the AA helps educators with the development of course instruction and allows for more holistic measurement. Moreover, the methods provide a more comprehensive picture and more authentic information about learner's knowledge, skills, attitudes, and competencies which are developed during the teaching process.

According to the literature review, it can be listed alternative assessment methods as follows:

1. Performance Tasks

2. Peer Assessment

3. Self-Assessment

4. Portfolio

5. Rubrics

6. Project

7. Diagnostic Branched Tree

8. Structured Grid

9. Presentation

Performance Tasks

A performance assignment is a set of tasks that are required perform in order to create a product or conduct a task to demonstrate competence in a specific skill or standard subject. The tasks enable students an opportunity to express themselves, thus this potentiality creates advantages for all talented students. It also requires students to perform a task rather than select a response from two or more options from a list. Each student can find an opportunity to exhibit their own thinking and creativity because responding to questions quickly and accurately is not the only measure of student ability.

Performance tasks allow students to evaluate the learning that takes place in its nature. The tasks provide an opportunity to determine the progress of the student in the teaching and learning process, to define what students know and what they do not know, and also to understand points where it shows students' shortcomings, his weakness, and strengths in the learning process through real-life data. Furthermore, these assignments are activities, which aim for students to confer with problem situations that may be encountered in real life, to develop and measure students' high-level thinking (Demir, 2015). Namely, a performance task is any learning activity that asks students to perform to demonstrate their knowledge, understanding, and proficiency.

Performance tasks enable students to conduct their knowledge and abilities in constitute some form of product, presentation, or demonstration focused on key aspects of academic learning instead of requiring to select an answer from a ready-made test. The term of performance assignment commonly indicates substantive activities either short-term, on-demand tasks or curriculum-embedded, project-based tasks that yield reliable and valid scores. The outcome of the performance can be included writing, research reports, presentations, and works of art, performances student self-reflection, and so forth. The tasks are routinely used in certain disciplines include visual and performing arts, physical education, and career technology where performance is the natural focus of instruction. However, such tasks should be used in every subject area and at all grade levels.

The performance duties design to consider sufficiency in reading, writing, speaking, and research, analysis, presenting, and creating. In a sense, learners have bestowed a scenario

that establishes aground in real-life content. Accordingly, performance assignment evaluates on performing an examination in science, creating a product on computer demonstrate functions in mathematics, analyzing source documents to compare them to different historical points of aspects in social studies, conducting a multi-media presentation in English class, acting out a character in a theatrical production, or completing a painting in an art class. Then, the learners gather information about the subject or theme of a course by reading and reviewing literature, articles, and videos. The learners are supposed to get a mark on the knowledge provided, taking into consideration the task they are presented in the scenario. Those learners' outcomes require a checklist, a well-designed rubric, or some manner for scoring students' performance assignments properly according to the assessment criteria.

What performance task is not? It is easily defined in general that particularly, the performance task is not multiple-choice testing, not an essay, short-answer test, matching, true/false testing, or problems with a single correct answer, and also not filling in the blank questions. Students supposed to build an answer, reveal a product, or conduct an activity. From this point of the assessment, the performance encompasses on a very wide range of activities, including completing a sentence with a few words, writing an essay a thorough analysis, conducting and analyzing a laboratory investigation, presentation.

Considering Points at Arrange Performance Tasks

- Time given to students to complete their tasks should be adjusted according to the quality of the performance in the assessment process.

- Performance tasks include multiple skills.

- Some of the performance tasks should be assigned as individuals and some of them as group tasks.

- Performance tasks should focus on outcomes and processes.

- The tasks comply with the curriculum's gains

- Performance assignments arrange according to students' level

- The assignments fit students' social-economic status and local facilities

- Related to the learning process

- It should include new and unique situations where information to be used

- Should be capable of being done by students

- Instructions, which students will follow in preparing process schedule in order to achieve learning objectives

- Shows some similar performance tasks, and students to be prepared for the tasks before starting to perform their abilities

- Prepares a rubric for learning aims, and the rubric includes worthy of notice criteria during preparing performance assignment (Butler, McColskey ve O'Sullivan, 2005: 45).

The Significant of Performance Tasks

Performance tasks have multiple advantages, which enable teachers to assess all aspects of learning values be formed in students are to reverse simply traditional assessment boundaries. Particularly, the performance duties that affect all students' knowledge include writing, speaking, thinking, problem-solving, and social skills. The utility of the foundation of performance tasks is how teachers to be taught and how students to be preferable learned. Accordingly, the aim is not only to improve education but also to develop students and teachers' learning and teaching ways. The performance allows students to construct or perform an original response rather than just recognizing a potentially right answer out of a list provided, performance assessments can measure students' cognitive thinking and reasoning skills and their ability to apply knowledge to solve realistic, meaningful problems.

A performance task is one of the useful alternative assessment methods due to asking to prepare a unique reply by the learner to single or more in time comprised in the evaluation. This kind of assessment method assists trainers to reveal not only learners what they know about, but also what they can actually do. Well-designed a performance task leads teachers to measure learners' comprehension levels, to support teachers to give learner feedback regarding misunderstandings, and issue directions during the learning process. Furthermore, such kinds of tasks can provide effective and informative learning opportunities to engage students with the learning process, particularly, students can be creative, inventive in any situation. The assessment process also improves reflection, profound learning about the task assessment topic, which can help drive improved student learning and their higher achievement. Moreover, these assessments are useful to improve student interest in their learning because loosely-defined performance assessments may present so many different and interesting ways for students to respond.

Some widely conducted research on performance duties indicates the performance duty is the potential to be aware to what extent the students have authentically mastered the

materials and bring good effects. One of the research demonstrates that performance duties initiate college students' motivation using some projects in the learning process, and thus the students are more engaged in the course, and their motivational and emotional state increases despite variance situations. Students gain high-lever abilities during their performance, oral presentation, and group works based on their experience. Another research that includes similar findings investigates the trend of using performance-based assessment in his twelfth-grade classroom of secondary level. The results show that most of the students are upward of encouraging and motivating in the learning after the performance-based assessment was conducted. It also found that the students are more successful, and they become easily adapted to this kind of assessment. They explore a diverse joyful pathway of learning, and so the statistic points out their achievement on the post-test was significantly improved.

The performance-based assessment in alignment with authentic assessments includes inquiry-based learning and problem-based learning strategies indicate the learners with a complex, real-world challenge in which the scenario, role, process, and product are all authentic; they must then demonstrate that they have the skills and knowledge to complete the task. Therefore, the learners effectively engage in the problem-solving activities instead of choosing passively an answer among options. For, the options are incongruous with assumptions which cover the learners perform well on a multiple-choice test that focuses solely on content, and so they are not able to aware of how to use their knowledge in real-life content. A test is traditionally employed after the teaching has been completed to determine how much of the content students have retained in. But a performance task can simultaneously promote student learning and gauge demonstrated skills. Thus, teaching, learning, and assessment all take place as the student performs the task (Chun, 2010).

The learners have not only skills and full of knowledge for particular course content, but they also gain the practice they need to be better critical thinkers on any scenarios or problems they encountered. It does not matter within the same domain or across domains providing they complete a sufficient number of performance tasks. Because the main purpose of teaching is improving the students of transferrable skills and knowledge.

How to Create Performance Tasks for Learners

Identify goals of the performance task:

Teachers' expectations are to challenge their students to use problem-based learning strategies when they encounter any difficulties and use critical thinking alongside exhibiting little codependency, instead, more individuality during fulfilling the task assessment. However, teachers do not anticipate students to count on their instructions on how to implement each stage of the assessment.

Select the performance assessment standards properly:

Common core standards to be steered towards performance tasks should be chosen after the aim of the task designated, then the criteria of the assessment are supposed to measure the learners' understanding and guidelines of conditional probability. Thus, it is needed to indicate the learning objectives, which involve the participation of the whole rules of how the task will be marked, to explain what should be at each step of the draft and final presentation.

Review assessments and learning gaps

One of the significant steps is to look at completed students' worksheets for the unit. The next step is to investigate what is missing and note that there are few relevant real-life settings, and then it is decided to create a performance task assessment based on founded on facts of life. Frequency tables require students to analyze as well as other graphs and charts.

Design a scenario

Doing brainstorming for a few diverse scenarios included some components such as setting, outcome, role, time, etc.

Gathering or composting materials

This step might be needed depending on the scenario. It can be created in different documents including charts, bar graphs, or tables.

Develop a Learning Plan

It should be sensitive in preparing students for the performance task because it needs a balance between teaching contexts and preparing students for the task. Performance steps need to be in place before students completed the performance. It also needs to be constantly reviewed by considering their learning demands.

Peer Assessment

Peer assessment is a process of a group of individuals evaluating their peers. The peer uses the knowledge and skills of students to explain, review and improve the works of peers in the process. In other words, the assessment is a setting in which students of similar status evaluate individually the works, learning outcomes, outputs, levels, value, quality, and success of their peers. The main purpose of this setting is to identify the difference between the expected performance and actual performance, thus giving the students the opportunity to improve, supporting their learning by providing them with enhanced feedbacks.

Peer assessment, used as a tool of performance monitoring by educators, or a tool of reflection by students, is a method adopted differently by instructors to increase pragmatic efficiency while reducing their workload. Particularly popular among teachers as an alternative way of evaluation, Peer assessment has received much attention in recent years for its effectiveness in the learning processes of students. This novel strategy of evaluation and learning is broadly used in a large variety of areas. The nature of these evaluation activities varies with the different areas of use, or the curriculum. Even production of widely diversified products or outcomes, portfolios, private presentations, and performance tasks, as well as other acts that require skills, maybe evaluated through peer assessment.

The participants of the peer assessment application may be assessors or assess, in parties varying from pairs to larger groups. Moreover, peer assessment may be applied one-sidedly, or reciprocally. The purpose of peer assessment application may vary from cognitive or metacognitive attainments of teaching to time-saving, etc. Further, the attainment of positive results incentivizes the in-silicon application of peer assessment. Ultimately, peer assessment may take place within or outside the class; it is experienced not only in school but throughout our lives. We all expect to be the assessor or assesse among our peers at different times and contexts. In conclusion, the application of peer assessment in schools may improve the transferable skills used in daily life.

Significant of Peer Assessment

The recent years witnessed a never before seen growth in the numbers of students attending higher education institutions worldwide. Nevertheless, the rates of employment in many organizations are disproportionate to this growth. As a consequence, classroom sizes and the workloads of teachers increased dramatically. The increase in the then-current workload redounded palpably to the already grueling and tediously effort and time demanding field of assessment. Homework, which needs to be overly assigned if required comments and feedbacks are detailed, is rendered almost impossible to pursue due to the incompetency of the grading system corresponding to the resources. In this vein, this situation does not result with the equation of "larger classrooms, fewer resources, and more competition"; on the contrary, in cases of large classrooms, it reduces the time that the instructor spares for each student, as well as meaning that students will receive the feedback they need for their homework less frequently. The situation is not projected to change in case of further proceeding of cost-cutting measures.

One of the most encountered problems in the academic sense is the question of how to provide high-quality evaluation and feedback in crowded classrooms, for the number of students per teacher does not seem likely to change. A possible solution to this problem is to involve students in the learning processes and nontraditional evaluation approaches

such as peer assessment. This approach creates the opportunity to use time more efficiently for both the teachers and students who attend crowded classrooms, as well as improving learning efficiency, saving time in grading and feedback processes, and increasing the frequency of quantitative-qualitative feedbacks. Moreover, peer assessment is found to be effective in the improvement of interpersonal relationships within classrooms. Many other studies too, emphasize that peer assessment has a positive impact on cognitive, metacognitive, and social impact areas of students, and its necessity for students during their education. For the aforementioned reasons and more, peer assessment is a method needed to be employed.

Advantages of Peer Assessment

Peer assessment has been successfully applied in preschools, elementary, middle, and high schools, including with special educational needs. The literature has indicated that peer assessment can result in improvements in the effectiveness and quality of learning at least as good as gains from teacher assessment. The benefits of peer assessment can be listed as follows:

- It gives students the opportunity to participate in the planning of their own learning schedule, as well as helping them identify their own strengths and weaknesses;

- It enables improving procedures at learning points, the target areas, as we call them;

- It helps in the development of metacognitive and transferable skills, production of an enhancing impact on reflective thinking and problem-solving skills throughout a student's education life.

- It is effective in the development of verbal communication and reconciliation skills, as well as of giving and taking criticism.

- It incentivizes students to have a sound grasp of the goals and purposes of the lesson, as well as the evaluation homework.

- It pushes the assessor to focus on the question of what the constituents of work, good or bad, should be.

- It enables going beyond the customary process of assessment, thus helps students comprehend why and how they will be rewarded with grades.

- It helps students have a better understanding of the requirements for the attainment of a certain standard, and enables them to be cognizant of the assessment process' details.

- When used effectively, it improves the quality of the work subject to assessment, as well as augmenting the understanding ability and self-confidence of students.

- It enables students to learn from each other's mistakes, criticize and review the performance samples of their peers by letting them study various writing styles, techniques, ideas, and skills (Race, 1998);

- It provides the opportunity to spotlight the contradictory applications employed by teachers in grading processes, and emphasize the importance of a work prepared in a clear, understandable, and reasonable format.

- It incentivizes students to reflect their own evaluation approaches on their evaluation homework.

- It constructs the cooperation of peer assessment in the development process of interdependent learning, mostly enabling the development of those skills effective at the interpersonal level, rather than inciting competition

Concerns about Implementation of Peer Assessment

Several problems and limitations have repeatedly been associated with the process of assessing although the adoption of peer assessment is advocated in the literature. Most of these arise from the fact that the application of the peer assessment method in higher education as a stylistic assessment tool is still a novel idea. Academic personnel, teachers, and students' lacking proper experience concerning this method of assessment can be given as an example. With this regard, students expressed dislike in assessing their peers and preferred the responsibility to be taken by their teachers instead.

Another remarkable negative aspect of the method is, that many teachers, who manage to involve their students succeed in the learning process through cooperation, somewhat leave the internal control and management of their classes to their students. Nevertheless, some teachers are concerned about peer assessment's integration into the assessment process. The reason why is that students become a part of the assessment and grade their friends. What needs to be done, instead, is to involve them in the assessment process but leaving the final process of grading to teachers. Among the reasons are the example situations in which, close friends give better grades to each other and these being make-up grades, grading is prearranged, dominant students being given the highest grades, ultimately, even those who didn't even participate in the work benefit from the group grading. Avoidance of this negative situation can only be achieved through the employment of peer assessment along with self-assessment.

Pedagogical Merits of Peer Assessment

The educational merits in the application of the method of peer assessment, which is adopted in various stages of education, are approached in broad strokes for a remarkably large number of students benefit from the method within the process.

Feedback

The primary purpose of peer assessment is to provide students with feedback; therefore, this feedbacks should be confirmatory, suggestive, and ameliorative. Polite and positive feedbacks help reduce mistakes, improve knowledge, construct theoretical knowledge more profoundly, and create a positive impact on learning. The most prominent feature of peer assessment is that it is efficient since the students always outnumber the teachers in a class. Moreover, students tend to take the feedback given by their friends as transitory and individual, whereas those they receive from their teachers are construed as feedback of the authority. Therefore, feedbacks taken from peers are more substantial and beneficial for students.

Cognitive Gains

Peer assessment gains are associated with both the assessor and assesse. This method of assessment can improve reflection on new situations, generalization, and metacognitive awareness, as well as incentivizing self-criticism. Therefore, the cognitive and metacognitive gains occur before, during, and after peer assessment application.

Improvements in Works

Peer assessment, like cooperative learning, is an evaluation method that can complement other approaches. In a group where students evaluate each other, for instance, criticism received from peers is considered to be more motivating by individuals in terms of improving the quality of the product. Further, students who participate in the peer assessment as an assessor are expected to be more inventive. Thereby the personal performance and the quality of the product are improved.

Saving Teachers' Time

It is stated that the method saves time for teachers since all students are assessed at once when students are involved in the assessment process. When the literature is considered, it is also seen that the method does not place a time-wise burden on teachers. However, some authors warn that it takes time to set up a quality peer assessment environment in senses of its organization, training, and monitoring processes. To avoid time loss, peer assessment should be used as an evaluation method when needed, rather than as a complementary comment to the feedbacks teachers provide. Otherwise, this method of

assessment turns more into a time-consuming application than a time-saver.

Guidelines for the Implementation of Peer Assessment and Evaluation

It is essential that the assessment to be carried out during the teaching process is well-set and planned. A well-set setting leads to lasting and productive results. Secondly, it eases the implementation process when the peer assessment to be held in the education process is planned well, is in harmony with classroom activities and teacher's feedback. Therefore, considering these steps will make it easier to apply the method. When the literature is scanned, it is seen that the guidelines concerning the implementation of peer assessment are as follows:

Setting Expectations

It is essential to collaborate with colleagues, rather than establishing an individual setting. Once the setting is ready, the students to be involved in the process should be informed on the importance and the scope of the assessment. In the next stage, setting goals, taking student expectations into account, informing students on the procedure of assessment, organizing activities to explain expectations and their roles in the process render the process easier.

Matching Participants and Setting Contract

Pairing the participants, and organizing the communication. Mainly, the purpose should be to pair peers with similar abilities. If the peers attend the same classroom, they can be classified roughly according to their abilities. In this way, those student groups or pairs from the lowest levels of the classroom can participate in works corresponding to their levels; nevertheless, with the support of their teacher, these students too may gain more than expected, as they will be involved in a similar process although at a lower level.

Monitoring and Coaching

Quality education makes a remarkable difference. The students should be informed of the expectations from them, including the roles and actions to be taken by the assessors and assesses. In the next stage, the assessment process should be explained through a simulation of, for instance, two students assessing each other. For this, the assessor and assessee participating in the simulation should be monitored, given feedbacks if need be, and trained.

Evaluation and Giving Feedback

Convey your own observations as the evaluator to the students on their performances, and examine the reliability of their assessments. For this, teachers should keep their

expectations low while applying peer assessment in the beginning and guide their students by giving feedback. Those students at lower levels in particular should be encouraged. In this stage, teachers should compare their own assessments with their students, and discuss with them if there are major differences. This way, the differences will be observed to reduce in time, and the assessments peers made among themselves will yield better results in a sense of reliability.

Self Assessment

Self-assessment is a method often used to foster student-centered learning, increase understanding of the learning process and reflection of insight of it, and encourage students to learn actively. In other words, self-assessment is defined as a process of observing, evaluating, understanding, and developing skills in student's behavior and thinking quality during the learning process.

Self-assessment, which develops students' own learning improvement step by step, enables them to be productive in the subjects they want to work in the future, and ensure to realize their own capabilities can be explained as students' judgment of the learning process of their own learning particularly their success level and learning outcome. The Foundation the aim of the assessment is to improve students' self-assessment skills because lifelong learning requires students' not only to work independently, also to evaluate their own success and development. After activities related to this obligation, purpose, or related sub-acquisitions, self-assessment forms are applied at certain intervals to see how well the students have transferred these skills to their lives or improvement that the practitioners have made on students.

Why Self-Assessment

Self-Assessment promotes students in the learning process, and thus formative assessment theory supports the necessity of using self-assessment. Some sectors and experimental research on children in certain age ranges indicate the significance of the assessment for encouraging student learning. Self-assessment is one of the prime types of assessment methods things to do for providing effective learning that students need, acquisition of lifelong learning to evaluate accurately strengths and weaknesses of individuals, and their professional developments in the future. Therefore, it is crucial to gain the ability of self-assessment at of early age and also maintain at other education stages.

Students opt for self-assessment for assessment conducting by teachers because the assessment is more equitable, increases clarity about expectations, and provides students feedback they could use to enhance the quality of their assignments. Students emphasize that with self-assessment they focus on what they need to improve, whereas with teacher

feedback they focus on the grade or areas they fulfill well. Accordingly, self-assessment is not to signify learners cultivate their notions in isolation from aspects and judgments of the rest. People live together in a community, share mutual customs and traditions, and understanding. Thus, teachers, peers, or expertise are individuals of great importance for assessment, particularly teachers' behavior and expectations have a vital influence on students. All assessments by teachers, peers, or expertise have been measured by one's own assessment in aspects of learning, a useful part to conduct, and might control learners' access to learning facilities. However, assessment is of little educational value unless it helps develop and informs of the learners' ability to self-evaluate.

Advantages of Self-Assessment

Self-assessment is to engage students to increase learning and achievement in careful, to boost academic self-regulation, or the tendency to monitor and manage one's own learning. The regulation and accomplishment are nearly engaged: As compared Students who know their aims to students do not know, it is clear that those who set the goals perform responsive plans to conduct them, and pursue the progress tend to learn much better in school. The essence of self-regulation is self-evaluation due to the fact that the evaluation involves awareness of the goals of duty and investigating one's improvement toward them. Self-regulation and also achievement can increase in consequence of self-evaluation.

Some of the research data based on teachers and parents demonstrate self-assessment increasing learners' achievement, constituting their motivation and perceptions, and affecting their desire to accomplish a complicated duty. Furthermore, it performs a potent relationship between learners' motivation and academic success as well as contributing to their learning. Moreover, a well-prepared self-assessment by the teacher provides feedback and gains a sense of belonging. Over against, a teacher is preferable to promote the changing needs of each learner.

Parents, caretakers, and teachers' feedback regarding students' behaviors, intelligence, and skills is to initiate the awareness of supraliminal at an early age. Thus, the feedback shape child's own understanding as a person both learner and personal. Accordingly, children with high prospects for school achievement and positive self-assessment are likely to be more successful in fulfilling the changing demands of primary schools.

Self-assessment is one of the alternative assessment methods. The assessment plays a vital role in compromise students' perceptions, advancing their success, and improve the responsiveness of their academic achievement. Nevertheless is thought that self-assessment is less reliable than other forms of assessment methods in general due to an individuals' own assessment. However, self-evaluation constitutes a crucial aspects insight of the whole Picture alongside other assessment methods, which evaluate

students' learning progress.

Disadvantages of Self-Assessment

The reliability is the most obvious and discouraging issue in implementing self-assessment because students' lack of experience in self-evaluation believes mistakenly that and leads to mistakes, biases, and deceptions in self-evaluation. Particularly, it is valued challenges in the implementation of self-evaluation in primary schools. One of the foremost challenges is the lack of understanding of what children can achieve. Thus, young students need to mostly boost and assist in the fulfillment of self-evaluation than older students. Unfortunately, some adults misapprehend the natural development of children's abilities, and as a consequence, advise that self-evaluation strategies are not effective, do not meet their metacognitive skills, or only provide superficial data about children's tendencies and what they are capable of.

Another disadvantage of self-assessment in the learning process is students being excessively firm on themselves. This situation similarly originates from a misunderstanding of the assessment and what it is they're being asked to do, but can also have implications on learner confidence and self-reliance. It often stems from a place of low self-esteem, which can have a negative impact on their future studies.

Teachers and parents are not interested in self-evaluation excessively due to requiring considerable effort, time-consuming particularly in first grades, not marking depending on self-evaluation, and not providing continuity on diverse students group. Therefore, some teachers are to concern valuable time for standardized tests is being devoted to self-evaluation. Nevertheless, self-assessment enables actually significant opportunities for identifying students who misunderstood the evaluation, are struggling with low self-esteem.

Portfolio

A portfolio is to use in a wide range of fields in general for ages, however, the use and implementation of the portfolio in education started in the 1990s. Diverse types of fields, such as artists, actors, photographers, and artisan have long employed portfolios to exhibit and register their craft. The using portfolio in instruction in the learning-teaching process is not new; nor is the usage in assessment a new practice.

Teachers have been successfully used portfolios to assess their students' work in the arts, humanities, and also core courses, including mathematics, science, and language. Portfolios, such as a mathematics portfolio, an art portfolio, perform a collection of learners' work intended to enable evidence of their comprehension. Thus, a teaching and learning portfolio indicates the students' learning, teaching, and personal growth

in a subject alongside students' development over a period of time. One of the uses of the portfolio is as an assessment tool that enables students to display their collective comprehension of learning processes; the second is theories as students conclude their period of time as well as the recording of that learning to be used as an introduction to the workplace. Hence, cultivated a proper portfolio can increase interaction between student and teacher, and ensure additional information regarding the student's progress and needs. The main purpose is to select and store students' daily work and important examples of assessments on a file.

Portfolios using as a method to encourage student learning are to become gradually popular in a variety of scope of education, and so it is not possible to make a sole definition for the portfolio because its definition may change according to the user and the aim of using portfolio. A portfolio is generally defined as a portable case for carrying newspapers, prints, or artworks. The portfolio is also defined as the collection of selected studies from the learning content in order to demonstrate students' learning. Some of the experts define portfolio as for the purpose of collection of work that showcases students' efforts, development, and achievements in one or more scopes. According to Grace (1992), a portfolio is "what the child has learned and how she has gone about learning; how she thinks, questions, analyzes, synthesizes, produces, creates; and how she interacts--intellectually, emotionally and socially--with others" (p.1).

Portfolio, which is known for so long, submits a comprehensive alternative assessment tool for both teachers and students. It is to create and maintains a control mechanism for students' work and documents; provide the shortcomings of students pertaining to the topics; enables students to analyze and realize what are good at, and all participants to be aware of their own deficiencies alongside noticing the developmental reflections of the strategies aimed at increasing the progress of students' skills. Accordingly, unlike standardized tests and key exams, the portfolio assessment allows students to review various studies and investigate the process from different perspectives. This is an approach in which unrelated and comprehensive studies are evaluated with a final grade in contrast to methods that are evaluated with a single grade. In this approach, it is collected studies including learning activities created from different perspectives in addition to the studies that have been done by students for a specific purpose. The collected studies enable teachers, students, or parents to understand the academic success of the students, the progress of their students in the process, and evaluate the learning process. It also ensures evidence for the student to observe the reflections of learning and change in the working process.

The portfolio is a record of the child's process of learning and was designed as an alternative assessment method owing to the fact that it is realistic and active. Hence, differently from traditional assessment methods, it considers not only the outcome of the learning, but also the process. The approach of a portfolio is the most important way to grasp the complex learning process because it deals with learning, teaching, and assessment in tandem. The portfolio enables teachers to attain quite a few of their most important unobtainable purposes, such as the observation of growth in students' knowledge, skills, and attitudes. The controversy concerning the goals and utility of portfolio proceeds with the recognition that portfolio occurs a core assessment method within the scope of education while acknowledged the trouble that they could become over-employed and may not be representative of learning. Thus, Marzano (1994) stated that a portfolio should not be used as the sole assessment approach considering the objectives of the assessment, but the other formal and informal assessment methods should boost the portfolio. Conversely, Danielson and Abrutyn (1997) indicate that it is a small wonder that portfolio is becoming as popular among trainers as they believed that the `portfolio was a single strategy that did it all' (p. 5).

The Purpose of Portfolio

Portfolio assessment is assumed as one of the alternative assessment methods due to covering authentic samples of a student's work. Many of the portfolio assessment's defenders emphasize that including students' outcomes makes the portfolio a predominant assessment instrument because it reveals the students' learning and their improvement over an extended period of time. The defenders have faith in the portfolio is a more true indicative indicator, which demonstrates learner's abilities truly than multiple-choice tests that enable immediate processing about what the learners can conduct within a short time. The portfolio is employable to point development in time; boost the learners' skills, and assess the learner's learning inside of a course or it can be combined all of three scopes. However, teachers should guide the portfolio process for establishing the aim of the final portfolio.

Portfolios are usable to achieve many purposes and make educational arrangements. It is used from universities to public schools to prove students, faculty students, staff, administrators' own individual performance and growth. The purpose of using a portfolio for students is to document the student's affective and cognitive development; enable students to reflect their thoughts on their assignments, and increase teacher-student interaction. The purpose of using a portfolio for teachers is to document the activities done in the classroom in tandem; monitor the style and quality of the teaching; evaluate the strengths and weaknesses of the practiced curriculum, and to develop a career. Unlike traditional assessment methods, portfolio assessment propounds a way of assessing student learning. It also ensures for teachers an opportunity to monitor their students in

a broader context, including taking risks, developing creative solutions, and learning to make judgments about their own performances.

The Content of Portfolio

Multiple types of portfolios, including documentation portfolio, process portfolio, and showcases portfolio are functional for several significant aims at succeeding curriculum objectives in depth. The documentation portfolio offers a collection of yields from activities to drafts and fulfilled products in the course of time that indicates the progress and growth of a student. As for the process portfolio, its purpose is to combine a knowledge of students' own and their abilities toward mastery of learning, and so certificate entire stages of the learning process with particular highlight on reflection, metacognition, and think logs to demonstrate the importance of production process. Ultimately, a showcase portfolio is the best vitrine for students' completed works involving photographs, videotapes, records of work, written analyses, and dated artifacts because it provides mastery of key curriculum outcomes in due course. Those reflections enable students for demonstrating their individual growth and fulfillment of the ultimate product.

Portfolios display learner's efforts, progress, and attainments in one or more than one field of the curriculum consisting of elective content of students, picked and merit judging criteria, and proof of introspection. Hence, a portfolio cannot be comprised of any student products, a scrapbook, an album, a collection of photos, or a random collection of observations. It states that a portfolio, in general, includes chosen multifaceted samples of students' best efforts and systematic observations related to assess outcomes of instructional purposes. The portfolio may contain a wide variety of materials such as student self-reflection, research, problems and strategies, diagrams, photographs, pictures, group assignments and projects reading logs, teacher anecdotes, teacher-completed checklists, and etc.

Samples of student's weekly or daily work and written exams, poems, reading logs, sample journal pages, written summaries, audiotapes of oral readings, videotapes of group projects teacher notes, teacher-completed checklists, letters, self-reflective forms can be placed in a portfolio file. Furthermore, the portfolio may be involved reading passages written for informational and entertainment purposes, topics discussed in class and other experiences, teacher-prepared tests, quizzes, sentence completion questions, attitude questionnaires; story reading pieces, written introductions, student biographies, special projects, reaction articles written in response to the news in the newspaper. Moreover, the portfolio comprises students' written assignments (drafts or finished parts), group assignments and projects, students' letters, assignments that students find difficult to do again, and samples selected from special assignments, and teacher notes.

Portfolio as an assessment method has been successfully used in the evaluation of a

course, which offers a systematic teacher collection and learner progressive a literal endeavor during the learning process. In addition, the assessment is particularly popular for performance-oriented disciplines, including performing arts, physical education, clothing and textiles, food and nutrition, visual art and design, architecture, music, dance, and drama where artifacts of work speak to skills attained and developmental growth and maturity over time. In this way, portfolios enlighten students, teachers, and significant others. Thus, they are used effectively as a communication tool for monitoring students' progress in reading and their improvements, and by teachers to keep an account of observations and the students' work as supporting convincing proof of conclusions they draw about students. They are also influential in enabling teachers with a list of instructions that base instructional decisions for the evaluation of student progress. Moreover, they provide information about outcomes to improve teaching, which is one of the major dimensions of high quality of assessment.

The Use of Portfolio

Portfolio assessment made a remarkable prelude in the 1990s and drew an evaluation image with great promise. Evaluation would correct the faults of traditional assessment practice; assist, but not harm or destroy the process; act as a bridge for the success of the student in the learning process, but would not prevent the evaluation. A portfolio is a great number of appealing and potential advantages in particular as compared to traditional standardized tests because it includes educational products that are clearly presented in the classroom.

The Pros of Using a Portfolio Assessment

- Participation of students in preparing their personal portfolios makes them active in their learning.

- Supports the purpose of being a lifelong learner, values , and increases feelings of self-efficacy.

- Describes what students know and what they can do

- Enables students to gain and develop a multidimensional perspective over time.

- Stimulate learners to participate in a portfolio and reflect their own thoughts.

- Provides a link between teaching and assessment.

- Portfolio, as a student-oriented approach, encourages students to actively engage in every aspect of their learning such as arranging purposes, choosing strategy

and materials, and assessing the outcomes (Lo, 2010).

- Grades the process instead of a result-oriented single grade since it provides students an opportunity to exhibit and see the works they have done in the process, and so the process of learning evaluates.

- Give learners an opportunity to focus their own attention on the learning process; motivate them to learn with meaningful and interesting activities; develop cooperation between student-student and student-teacher; participate in the assessment together by student and teacher, and evaluate in a systematic way by a teacher.

The Cons of Using a Portfolio Assessment

- Improving and assessing a portfolio is time-consuming. For, it is a demanding effort in which you can rapidly drop behind and takes much time for both learner and teacher.

- Portfolio assessment is inherently subjective. Teachers use a rubric to assess students, however, the nature of a portfolio obstructs the assessment to remain objective and true to the rubric. In spite of similar students working on the same learning standard, they might have completely distinct approaches as learning may not be the same.

- Marking a portfolio cannot be easy because of the differences among each one. A well-prepared rubric enables a teacher to mark the content of a student's portfolio, however, even then, the scores of subjectivity complicate to assign marks of a portfolio reasonably when investigating one portfolio towards the other one. Yet another grading challenge with a portfolio is to let a student making a show of her strengths but conceals her weaknesses, and thus portfolio provides an unfilled picture of what a student comprehends. A portfolio in general does not include in the scope of a student's ability to remember only the facts either, and thus it cannot stand alone without other more traditional forms of assessment to go with them.

Rubric

A scale list of criteria that prominently describes what a range of appropriate and inappropriate performance looks like for the teachers and students. These scales contain a set of criteria that are relevant to evaluating, belief, practice, performance, and producing an effective assessment. In a general sense, it is described four or six levels of quality for each criterion in a rubric. It also assists learners to assess themselves, and understand what is expected of a task, and what expected quality of the task is, and what

results of product look like. Although educators incline to define the word rubric in slightly different ways, the widely accepted definition of a rubric is a document in which expectations for a task by itemizing according to certain criteria and values, or what criteria count, and representing of levels of quality from excellent to poor. Rubrics have become widespread with the use of teachers as a means of communicating expectations for the task, enabling focused feedback on works in progress, giving a grade to the created products, and expressing the criteria that should be met for the evaluation of the assignment.

The use of rubrics is poor in spite of being known widely by teachers. The underlying reason is that the purpose of the rubrics is not quite understood by the teachers; it is thought the rubrics' validity and reliability is a drop in the ocean, and to be confusing by the students and parents, and the using of rubrics takes a lot of time. However, the rubrics provide for teachers accurate and comprehensive assessment opportunities in evaluating students' processes, skills, and products when they are considered as an assessment tool and designed in view of the fact the stages of writing, comprehension, and development. Rubrics are also employed to give a grade to student outcome and can teach as well as evaluate. Furthermore, they have a perspective to attain reliable decisions about the quality of students' own work along with developing their understanding and abilities. Moreover, they are a student-centered approach to use as an assessment method when used as part of a formative to identify students using evaluation.

Checklists are an appropriate choice for evaluation in limited situations concerning whether certain criteria for performance are met, however do not have possession of a structure defining performance levels. The rating scales can define the performance of the measured feature at various levels and allow to see to what extent the criteria are to be satisfied. Rubrics are similar to checklists, but checklists are simply answered "yes" or "no" questions. As for rubrics, they have performance grades such as low-medium-high (Quinlan, 2006). Namely, the difference between any rubric and a checklist is to make only a list of the criteria for an assignment. Checklists are incapable of doing what rubrics are able to do, including define desired qualities and prevalent pitfalls in learner tasks through checklists can be used as a helpful assessment tool.

Advantages of Rubrics

Rubrics orient teachers at all levels towards learning goals, from primary school to graduate level. These clarify the purposes of learning, design of instruction in line with these purposes, communication the objectives to students, leading feedback on the progress of the students toward the goals, and giving of the grade corresponding to the final outcome in terms of the degree to which the purposes were met. The benefits of using rubrics are numerous, and thus rubrics are usable before, during, and after

homework.

Instructional rubrics lead teachers to clarify their expectations and focus on their instruction. Teachers set their goals for students to select or constitute a project that bridges over them learn and demonstrate their learning as well as designing a rubric for the project in order to commence the process of composing a course or unit. The criteria in the rubric allow students to experience each performance gradually, and to determine what students are able to do and their values. Also, rubrics provide a quick and clear assessment of performance levels, and thus it is an invaluable implementation for teachers and students. The created rubrics for the evaluation of students' and in particular teachers' student work constitute a substantial aspect of alternative assessment. Because instructional rubrics facilitate teachers to manifest the learning process, performance, and student progress.

Teachers ensure the formation of higher quality products and increase the reliability of the criteria as they determine the criteria and standards of assignment in tandem with their students. In addition, the rubric prepared with the cooperation of the teachers increases students' self-worth, academic self-values , and willingness to work academically. Rubrics mitigate contradictions and deficiencies in the evaluation process and provide students with explicit information about their own inadequacies and competencies when teachers share their decisions about students' evaluations using rubrics. Rubrics enable assessment of the purpose and focus attention on key points of performance, and ensure student-specific feedback on the level of performance (Demir, 2010). Feedbacks have an aspect of pedagogic thoroughly, and this demonstrates the student's development in the process, particular strengths and weaknesses of the issued duty with the feedback to themselves through the rubrics.

Rubrics evaluate students' assignments quickly and efficiently and be the assistance of teachers to present guardian of students and whom it may concern the scoring of students' work. The best rubrics are those that support students' learning and develop complex thinking skills with instructional tools. Rubrics serve the purpose of learning as well as an assessment when used properly. They reveal the unexplicit distinction between teaching and assessment, such as portfolios, exhibits, and other authentic assessment approaches. Hence, they are very frequently preferred in terms of teaching.

Rubrics also gain much favor with students. The students perform their assignments according to required objectives when they know the criteria in advance of their performance task. Besides, well-defined criteria provide for a distinct description of quality performance, and thus students don't need to guess what is significant, what is insignificant, and how teachers will judge their performance tasks.

Disadvantages of Rubrics

Rubrics create a problem in terms of time-consuming, explaining orally to students, and giving feedback. They are not entirely self-explanatory, and thus students need to be informed about the meaning of the criteria in the rubrics, understanding rubrics and their use. Rubrics cannot replace an effective teaching method although a perfectly crafted rubric cannot change the reality of providing a model that student needs, feedback, opportunities to ask questions, lecture repetition, etc. Anyone can download a rubric from any website and resource, however, using it as a decent instruction tool is another problem. In addition, beyond grading, rubrics are not exactly a decent tool because it serves the purpose of learning and teaching as well as evaluation.

Students may not become aware of the qualities in their work although they know what to look for, because the students have a less improved understanding of how to common on the criteria. The distinction between teacher and learner decisions is properly attributable to the learners' fewer sense of the criteria used and indeed, not to the performance. Thus, it is asserted that rubrics should be fulfilled with bonding, or examples, to exemplify the diverse levels of achievements. The bonding might be enrolled in descriptions or, rather, genuine work samples. Though using rubrics is useful, the usage of rubrics may be remain limited by the quality of the scoring rubrics used to assess students' performance.

How to Create Rubrics

Before beginning the development of a rubric, the teacher should clearly visualize what is expected from the written project, product, or process. The expectations, or the vision of what the written work should look like, may be described in terms of "look for" (for example, the teacher will look for creative word choices based on the week's mini-lessons in writers' workshop or the expectations may be described in measurable standards (for example, "look for five paragraphs").

The first step in the development of rubric is to create scoring rubric steps in which the features needed are clearly defined, and a student performs adequately in his work. However, the teacher should clearly visualize what he/she expects from a project, process, or product before starting improving the steps of a rubric. The features or the vision demonstrate what the project should contain, the expectations may be described in measurable standards. Criteria should be developed in the rubric such as "excellent, adequate and improvement required".

After developing the criteria of a rubric, the chief point to the success of the project is to be considered by teachers asking the students' feelings at first. Then, asked the students whether they would like to have more time to work on a project; which components should be included more in the completed project; or would they rather have less time

and just a few criteria on the rubric, but more focused? Instructors may cooperatively improve a draft rubric that is valid and jointly shared with learner/instructor ownership by questioning students and listening to their responses. As it is conducted in this way, a valid and participatory rubric will be created a sense of belonging will be given to students.

A well-structured rubric can be used as an assessment tool because the criteria and characteristics in which the teacher wants to measure are included in the rubric. Evaluation is to be easier and more spontaneously in this manner. Both students and parents know which grade each individual can receive since teachers are practical in developing rubrics.

Developing Rubric Phases

- Determine the purpose of the rubric

- Define clearly the assessment points

- Decide on proficiency levels

- Create a key for the behaviors, products, or skills the assignment endeavor to measure.

- Write short criteria for the behavior, product, or proficiency level of each skill. The important thing here is to be able to distinguish the criteria between the levels. Skills can belong to a lower or higher criterion at any level.

- Give shape of a draft rubric

Points to Consider during the Development of a Rubric

- The set of criteria is to be consistent with the targeted objectives.

- The criteria supply the characteristics of the outcome

- Rubrics should be written definitively and perceptibly according to students' proficiency levels

- The scoring system should be meaningful and clear.

- Provide clearly the variances in performance levels (Moskal, 2000).

Types of Rubrics

Rubrics are divided as Holistic and Analytical, and the difference between these rubrics

varies depending on the type of work. However, a subtle distinction is located among them. Each item in analytical rubrics is separately scored, whereas a sole point is graded to all items in total in holistic rubrics. However, the analytical rubric chosen does not rule out the possibility of holistic rubrics.

Holistic Rubrics

An advantage of holistic rubrics is their efficiency in assessing a single skill like writing proficiency. The timed, impromptu essay, which traditionally employs holistic scoring, is cited as the best-researched assessment type (Weigle, 2002, p. 59). First of all, teachers are aware of the advantage of assessment of their students' writing from the beginning of the semester compared to at the end of it. Second, a holistic rubric is to evaluate the performance of the students or all their work by grading a single point as a result of a comprehensive classification. Basically, the purpose of holistic rubrics is to mark a total single point evaluating the important items to be measured in the performance or outcome presented, which is seen in a sample below on chart 4.

A holistic rubric is a form of assessment that indicates students' abilities and knowledge and provides a comprehensive assessment of students' work within a framework alongside allowing teachers to assess better students' learning. Portfolios, reports, posters, pictures, oral presentations, poems, plays, essays, and laboratory findings are examples of holistic assessment rubrics. It is in general used for writing, other creative artistic works, and also enables for evaluation focusing on the whole product or process rather than dwelling on the individual elements of a product. Lastly, it is usable for the outcome of learning is required to be evaluated in a total point. It is identified generally the features of student performance. Particularly, the rating is a sole score based on the quality of student performance.

Holistic rubric

Score	Description
1	Application is complete and all materials are excellent. Candidate is clearly a great it for the program.
2	Application is complete and most materials are above average. Candidate is a potentially good it for the program.
3	Application is mostly complete with materials of variable quality. Candidate is an unlikely it for the program.
4	Application is incomplete and/or most (if not all) materials are of poor quality. Candidate is a poor it for the program.

Analytic Rubrics

Analytic rubrics compensate for a wide range of the shortcomings of holistic rubrics though they have validity and reliability issues. The primary advantage of analytic rubrics is their accomplishment to assess numerous features of a single performance, presenting a depth of data that can define particular strengths and deficiencies of a curriculum. Analytic rubrics employ comprehensively in assessing the performance of learners, and require planning and identifying the important knowledge, skill, or activity that the student needs to highlight. Students' outcome and their processes are divided into sections and each criterion and skill is independently evaluated, and then summed score estimates gathering issued points. Scoring in this way provides teachers and students with more detailed information about the strengths and weaknesses of students' skills than holistic rubrics.

The functionality of analytic rubrics is beyond any writing assessment purposes since the rubric can direct usability specialists on how to assess users' experiences with navigating their work. The outcomes from these assessments could perform a checks-and-balances system that illustrates a real efficiency of yields and services rather than supposed impact. Analytic rubrics are also like a checklist, each item is evaluated separately, and each of their grades according to itself on a descriptive measurement. It is ensured that each item is evaluated in stages and scored separately, and thus strengths of students and their weaknesses demonstrate in the studies produced by the students. With the conducted assessments in this way, students are better prepared for the future improving themselves.

Analytical Rubric Example

	Excellent (9-10)	Good (7-8)	Satisfactory (5-6)	Needs Improvement (0-4)
Idea explanation	Thoroughly explained ideas	Ideas explained	Ideas somewhat explained	Little or no explanation of ideas
Coherency	Extremely coherent writing	Coherent writing	Somewhat coherent	Lacks coherency
Grammar	Few errors	Some errors	Many errors	Many errors that hurt understanding

Comparing of Analytic and Holistic Rubrics

Evaluators evaluate performances using holistic or analytical rubrics depending on the purpose. The holistic rubric reflects the overall quality of the performance by giving a total score, and thus this approach is in general preferred to be used in the instantaneous evaluation. The analytical rubric provides an assessment of elements, including the content, appearance, and design of the performance in return for a score that meets certain characteristics. Each feature grades a single numerical grade averaged in the overall assessment. This method is recommended for daytime using because it guides evaluators in giving feedback for control.

Both holistic and analytic rubrics have validity and reliability. However, in the holistic assessment, a single score from each rater is calculated, so one of the advantages of a holistic rubric is to provide the ability to evaluate a sole skill. When any work is evaluated with a holistic rubric, evaluators notice the progress of the student by comparing the situation of the individuals at the beginning of the study with the situation reached. Analytical rubrics have reliability issues. Therefore, overly detailed analytical rubrics can reveal lead to a subjective rating based on the evaluator's interpretation. Nevertheless, analytic rubrics are highly reliable in particular with inexperienced raters and complete multiple of the shortcomings of holistic rubrics. Besides, the analytic assessment generates a higher rate of interrater reliability than the holistic assessment because of how the agreement score is calculated. It also provides in detailed data by defining the crucial points in the assessment. In the holistic assessment, a single grade is calculated from each evaluator. In a five-dimensional analytical rubric, contradictions between categories are proofread and the average grade from each rater is calculated.

Types of rubrics

Comparison of holistic and analytic rubrics (Weigle, 2002)

Quality	Holistic	Analytic
Reliability	Lower (most of the time)	Higher
Construct Validity	It assumes all relevant aspects of abilities develop at the same rate	It is more appropriate for L2 learners
Practicality	Fast and easy	Time-consuming
Impact	A single score may be misleading	It can provide more useful diagnostic information
Authenticity	Reading a rubric holistically is a more natural process	Raters may tend to read holistically and adjust analytical scores to match holistic impressions

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Project Assignment

Alternative assessment approach performs a new form of assessment for teaching and

learning with its challenges teachers have to cope with. Teachers are struggling with some assessment challenges during conducting project assignments as well because the teacher's task has been to "acquire formal knowledge, find efficient ways of sharing it, and determine whether pupils have learned what was taught" (Cuban, 1993, p. 248). The current state becomes different rather significantly during project tasks in which learners build their knowledge in tandem with their peers and teachers. The learners' role has altered from being a passive receiver to becoming an active learner and producer. Thus, the project, which is one of the alternative assessment methods, has become a compulsory element of education in the 1997 Norwegian National Curriculum. It was expressed to the teachers that the project assignment should contain 20% of their teaching process in the curriculum.

Project assignments have been used in education since 1997 for studies that students perform in groups or individually under the guidance of the course teacher; in order to examine, research, and comment on a field/subject of their choice; to develop opinions, reach new information; produce original thoughts and make inferences. In another definition, project assignments that cover music, media, art, science, language, and social sciences are to the purpose for students to produce something on their own regarding a topic in the curriculum.

Project work assessment, including both theoretical and practical aspects, generates a progressive teaching/learning approach that take aimed at boosting student's deal with complicated real-life challenges. The project can potentially transfer to learner's distinct and significant course topic content from multiple disciplines in concrete yet in the form of comprehensive. It increases higher-order thinking abilities such as problem-solving, value judgment, decision-making, and data analysis. Hence, this is highlighted due to the fact that learners reveal inquiries, collect information, comment on findings, and employ convincing proof to make inferences. It may be actively attended as a whole class, group, or individual to constitute a product to exhibit student's comprehension of natural and scientific phenomena. Some researchers claim that relevant project assignments also incline to be collaborative, open-ended, and generate problems with answers that are often not predetermined.

Project work is one of the ways that students implement at the point of showing and applying the learned knowledge. There are criteria developed in accordance with the stages of the project, so, those criteria are significant in that the students enable to understand what is expected of them. It is needed to create by students in tandem to determine the stages of the project criteria, students' interests, student and teacher expectations, designate the strengths and weaknesses of individuals, and their problem-solving skills. This situation provides more realistic project works to implement as it reflects the interests and skills of the students.

Some important inquiries should be asked during all project-based assessment process: What are the goals of the assessment process? Are we doing this assessment for whom? What is going to be assessed? Who is going to conduct the assessment? And how should it be conducted? (Calfee & Masuda, 1997; Franke-Wikberg & Lundgren, 1990; Gipps, 1994). Another inquiry could be how to assess all the stages that occur in the processes of project work. Then, the important thing in the project work is to determine the problem statement that is going to direct the student's work. Both teacher and student are responsible for determining the problem statement that composes the beginning of the project work. The teacher demonstrates to the students the connections about the subject, questions, stages they can examine, and the important points that they should focus on during the project process however, the teacher cannot by no means enforce the student to work on a project with a known outcome. The student is given a space to form the questions and answers of the study. The student plans the purpose of the project, the steps and strategies to be followed, the materials to be used, and the situations that may be encountered. The student can construct the work and get help in collaboration with the teacher and friends during the project process. Ultimately, the students can be evaluated on how they worked throughout the process and how they reached the result of the project study.

Considerations in the Preparation of the Project Assignment

- Project topics can be determined by the coterie teachers, and students can also determine a project topic individually or as a group according to their scopes of interest. Project topics can be related to a single field or interdisciplinary. The project topics given should be such as to suitable for the level of the students and can be done according to local opportunities.

- The process from the design to the exhibit of the project assists the development of scientific process skills as it includes scientific process steps. Projects, guidelines, and scoring standards should be prepared.

- In projects to be carried out in groups, it should be noticed for the formation of heterogeneous groups in terms of characteristics of students' gender and achievement, etc.

- Each group should create a work schedule for itself.

- The distribution of duties of the group members should be made clear for each stage of the project. The teacher's approval is obtained making the distribution of duty by the group members

- At each stage of the project, feedback is given to the group members by the

teacher whether the tasks are done or not is checked at the end of the stage.

Evaluation of Project Assignment

A teacher conducts an assessment of the project work and uses rating scoring scales (rubric) for the evaluation of these assignments. The outcome that students manifest in the process and at the end of the process is taken into consideration as making the evaluation.

Expectations from students in project studies and evaluation criteria should be determined in advance and shared with students. It is presented below some of the criteria that can be used in the evaluation of the project work done by students.

- ✓ Ability to work independently

- ✓ Collaboration with the group

- ✓ Accommodate to changing circumstances

- ✓ Ability to handle, solve or avoid problems

- ✓ Design and presentation of the show

- ✓ The originality of approach to the subject

- ✓ Theoretical skills/psychomotor skills

- ✓ Determining the aim

- ✓ Using time effectively and efficiently (Milli Eğitim Bakanlığı [MEB], 2009).
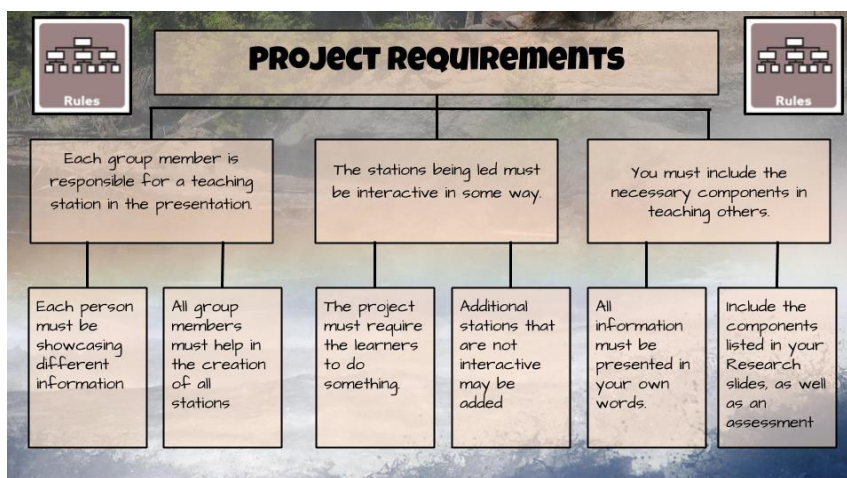

Figure 4. Project Requirements for Primary School Students

Diagnostic Tree

A student needs to establish a connection with course concepts with daily life experiences because interlink concepts enable related data to be permanent. Students construct concepts in their minds by confirming and adapting their own impressions as scientific truth in a meaningful coherent manner. They might indicate alternate concepts, which are against scientific facts in this process. However, students' misconceptions regarding their courses can be hardly in improving high-level concepts and linking previous knowledge with new one properly. Thus, students' alternative concepts should be identified at first.

The diagnostic tree is defined by Nichols (1994) as a diagnostic alternative assessment method, which "makes explicit the test developer's substantive assumptions regarding the processes and knowledge structures a performer in the test domain would use, how the processes and knowledge structures develop, and how more competent perform differ from less competent performers" (p. 578). Many techniques and strategies, which are named conceptual change strategies employed to reflect opinions and shifting misconceptions in the cognitive structure of the learners. Both Diagnostic Tree tests and Structural grid use as strategies of cognitive structure. In that respect, the diagnostic tree is based on designing for cognitive diagnostic objectives are unlike traditional assessment methods in that the tree does not only ground on logical taxonomies and features of content to identify purposes. For, the diagnostic endeavors to perform the content is indefinably oriented to discovery function of test in replying to questions or assignments.

Cognitive diagnostic evaluation is one of the alternative assessment methods that are similar to true-false questions, which is one of the traditional assessment methods, however, the diagnostic evaluation method uses to determine what students have learned about the subject, and what they have not learned. This true-false type of assessment method includes related questions, and results of each true-false decision that influence or indicate the next true-false decision. It is also an assessment tool that provides students to conclude by giving correct or incorrect answers to interrelated propositions placed on the diagram tree and aims to retain knowledge patterns with misconceptions in the minds of students.

A student is expected to choose a correct answer giving the right and not right statements in order from general to specific through the cognitive assessment method. Accordingly, it constitutes a diagnostic tree involving 8 or 16 selected questions. This method is used for identifying students' mistakes and shortcomings in their learning of topics; revealing their misconceptions; designating the prior knowledge of students, and realizing the learning under cover of theorems. Furthermore, the diagnostic tree is preferable to ask gradual questions on the same topic. Thus, the difficulty of the level of questions

increases as the number of branching enhances, and questions prepared from concrete to abstract or from general to specific are directed to students. The chance of success is lower compare to the multiple-choice test. However, it is not preferred much due to the difficulties in its preparation.
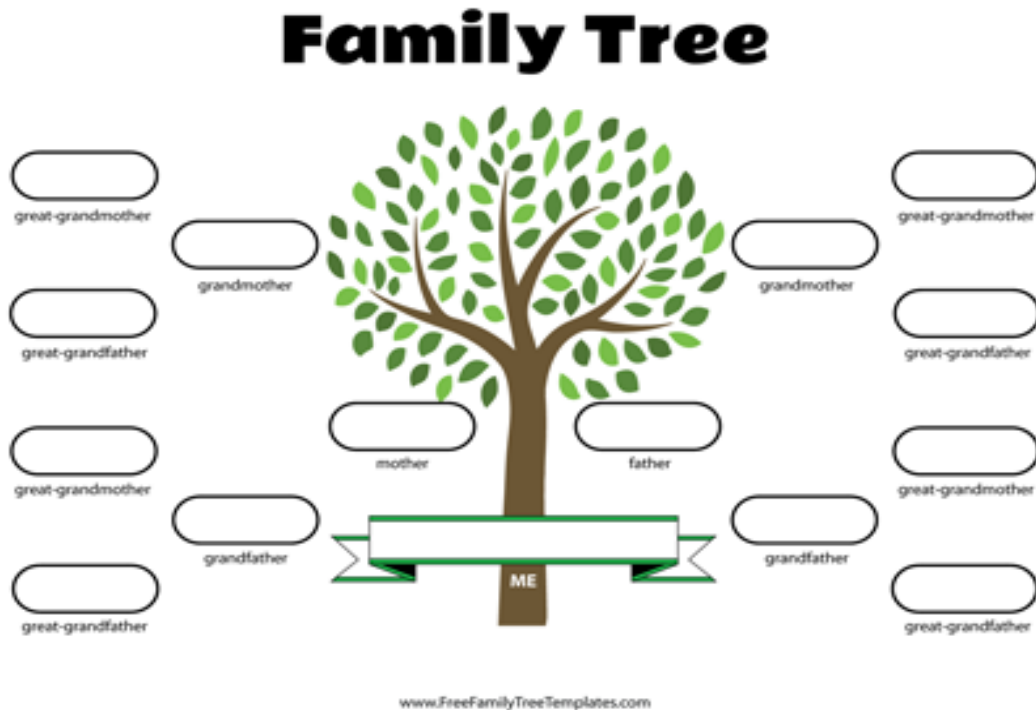

Figure 3. Diagnostic Tree for 3rd grade English Lesson

Preparing an Assessment Activity using Diagnostic Tree

The diagnostic assessment tree arranges at seven stages:

- Investigate acquisitions of the curriculum in which activities will be held

- Determine topics that students have more misconceptions

- Choose 8 or 16 true-false types of questions from theorems

- Place the questions appropriately in the diagnostic tree diagram

- Write the outputs of the diagnostic tree and complete it after the questions are placed on the diagram

- Write a short instruction that enables students to learn about the diagnostic branched tree

- Prepare statements like theorems that can be easily understood by students and are suitable for students' own level. It is ensured that the statements are prepared in a structure that can query an interconnected knowledge network. This is one

of the most important features that distinguished the diagnostic branched tree method from true-false questions.
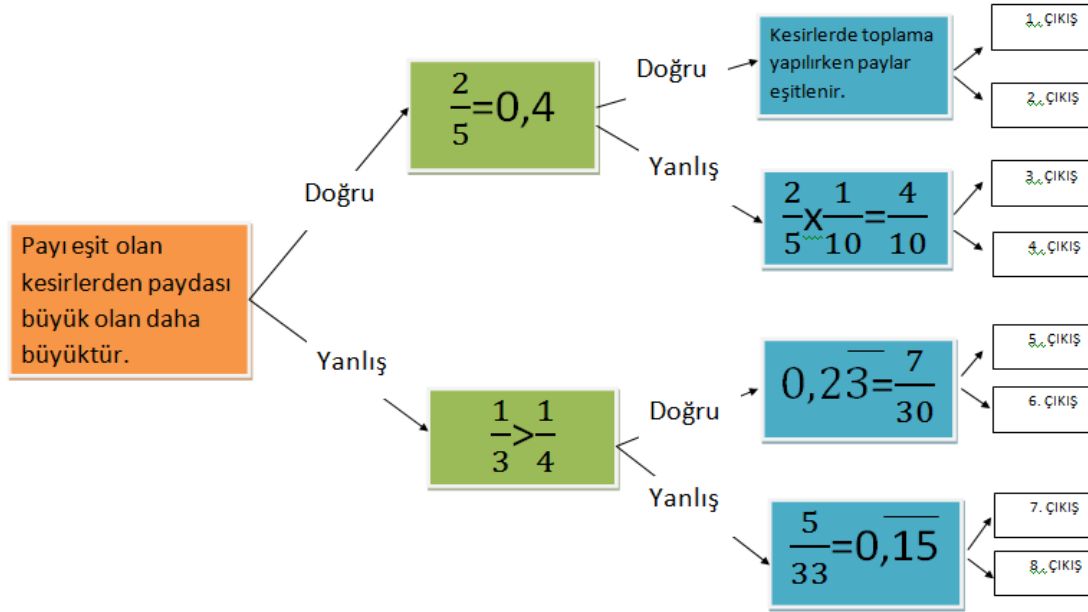

Figure 4. It is written Turkish, but: True (Dogru), False (Yanlis), Exit (Cikis).

Scoring and Interpretation of the Diagnostic Tree Method

As seen in the above figure, eight exit points are obtained indicative of the different paths followed by each student, and scoring conducts considering the followed process. Teachers determine how it is reached to exists, that is how many correct and incorrect expressions were reached. Then, the teacher can score and evaluate according to the number of true and false. Evaluation can be performed giving 1 point to the correct questions in the scoring and 0 points to the wrongs or questions are an array of general to specific and from easy to difficult. Each question has a scoring value according to its difficulty level. The calculation is done over 100, and thus, a student can easily comprehend which exit he get out and how many points this exit corresponds to out of 100 points. The evaluation regarding the diagnostic assessment tree is in Table 1.

Table 1

Exits	Answers	Points (P)	Total
1.Exit	1 (T), 2 (T) ve 4 (T)	25p+35p+40p	100 p
2.Exit	1 (T), 2 (T) ve 4 (F)	25p+35 p+0p	60 p
3.Exit	1 (T), 2 (F) ve 5 (T)	25p+0 p+40p	65 p
4.Exit	1 (T), 2 (F) ve 5 (F)	25p+0 p+0p	25 p
5.Exit	1 (F), 3 (T) ve 6 (T)	0p+35 p+40p	75 p
6.Exit	1 (F), 3 (T) ve 6 (F)	0p+35 p+0p	35 p
7.Exit	1 (F), 3 (T) ve 7 (T)	0p+0p+40 p	40 p
8. Exit	1 (F), 3 (T) ve 7 (T)	0p+0p +0p	0 p

Structural Grid

The structural grid is one of the alternative assessment methods, which gives an insight into the sub concepts and connections among students' own perceptions in order to assess their level of deep understanding. It is also to employ as a measurement tool to identify the performance of students in the learning process. Thus, structural grids provide a proper assessment method to realize these objectives alongside they are utilizable for diagnosis and evaluation. The grid was started to use as an assessment tool by Egan (1972) in his research and development of it are rooted other researchers for use in science (Duncan, 1974; Johnstone & Mughol, 1978, 1979; Johnstone, 1981; Johnstone et al., 1981; MacGuire & Johnstone, 1987; Scottish Exam Board, 1997). For, scientific information does not merely consist of lists of factual knowledge but is an interconnected network of ideas and concepts. Students should learn new ideas as part of such a related network of information. For this reason, this measurement tool is an important technique in terms of revealing the cognitive misconceptions and knowledge deficiencies of the student.

Traditional assessment methods, which are based only on multiple-choice tests emphasize the existence or non-existence of knowledge, however, they do not provide any information about cognitive structures that exist in the mind of a student, whereas alternative assessment methods, which measured knowledge of the learners do. As an alternative assessment method, the structural grid evaluates in part students' learning and highlights the deficiencies of each of the learners. Accordingly, the grid is one of the cognitive structure strategies in the form of a limited numbered grid focused on pointing out the cognitive structures of learners.

The structural grid method, including contents of the boxes, which covers words, phrases, pictures, equations, definitions, numbers, etc., is quite a change from multiple-choice tests because the learners are potentially selecting the boxes apposite to answer the question and to put them in logical succession respectively. That is why this technique is known as the "Structural Communication grid" (Johnstone, Bahar, & Hansell, 2000). The most significant feature of the grid is to gauge meaningful learning and exploring students' misconceptions; to highlight the usefulness of the grid for evaluation the objectives. It

also considers a substitute for multiple-choice questions due to being a useful diagnostic assessment tool as an alternative to multiple choice tests.

The cognitive structures of students are discovered using a structural grid. The size of the grid method ranges, and so the cells account designates each of the grids prepared concerning the level of the students. There is no exact, hard, and fast rule for the size of the grid test. Structural grids of diverse sizes and the cells of the grid are numbered as 3x3, 3x4, 4x4, which are developed in harmony with the range of the learners (Johnstone et al., 2000). The researcher exhibits developed 3x4 structural grid for the present book chapter:

| 1	2	3	4
5	6	7	8
9	10	11	12

Figure 5 shows the basic structure of the grid that contains numbers, however, the grid includes in general not only numbers, also a word, phrase, symbol, diagram, picture, etc., and thus the grid is an equal proper assessment method both for verbal learners and visual. The superiority of the grid from the multiple-choice test is based on the fact that it is precisely free from guessing casual agents. A couple diverse of scoring criteria are situated in two kinds of forms of proper and tailored questions. In the case of regular questions, only should be put elective boxes against each question. However, the grid is in equal terms of significance to place distinct cell numbers in a logical sequence for choosing a question.

The Use of Structural Grid

Concepts, pictures, numbers, equations, definitions, or formulas in the structural grid are randomly placed in boxes. Changing the content is important in terms of providing both visual and analytical thinking. The first question and put possible answers in boxes prepared by the teacher, and the second question and its probable answers are similarly placed in the same boxes. They could or not be connected to the first question and its answer to them. The process should proceed till the entire boxes are filled in. Each box, which covers a text, a graph, a table, etc., includes distinct sorts of alternatives and answers. This boosts teachers to perform objectively productive assessment decisions.

Students are asked different questions about a subject to mark the boxes, which they find the correct box for each question and arrange the number of the box logically and functionally according to their perceptions. Sometimes, they are asked in placed elective boxes in a designated order. This is one of the crucial points of view of the structural grid technique because they should choose the correct ones first and then locate them in the correct place. This feature demonstrates the superiority of the grid from multiple-choice tests. In this way, the learner cannot reach to answer by chance because not aware of a single correct answer to be selected, not knowing the number of boxes that are valid for each question to put potential answers in order. Therefore, it is determinable the misconceptions and deficiencies that occurred in the mind of the student from the wrong boxes chosen, and what they have learned from the correct boxes.

The below figures show some examples of the structural grid taken from the second exam in Turkey.
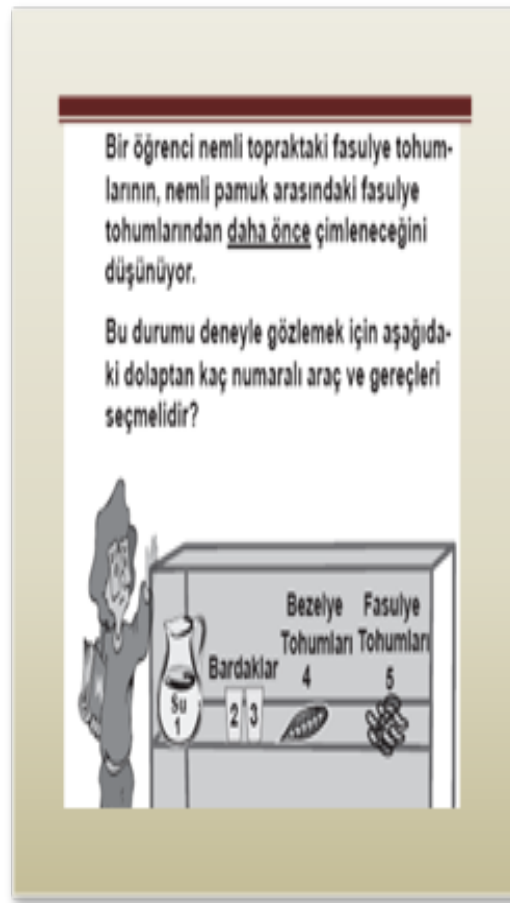
It is complicated to harness the grid using pencil and paper, and thus a structural grid tester which is software was developed. This program provides an environment in which a structural grid test could be designed and fully evaluated. The software promotes multiple distinct factors to be involved in the grid such as elaborated analysis of students' responses. The foundation virtue of the software relies on its capacity to evaluate students' responses. Thus, it provides users to get a clear picture of different student features.

Presentation

Presentation is one of the alternative assessment methods for sharing ideas of activity and illuminate comprehension verbally. The purpose of the presentation is to obtain the teacher to find out what students are thinking about a subject, and how they express it in their own words. Thus, presentation assignments should enable opportunities for the learners to think through questions and express their ideas. It also should indicate and clarify what they have mastered; verify their own perceptions, and reflect in their knowledge, and on the views of others.

The presentation may be used in many aspects of the field such as speaking, language training, and art. Students can be evaluated using control lists, rubrics, or peer assessment, and thus it provides good information about student's critical thinking skills. The presentation is a proper tool to collect data regarding the level of student's recall, comprehension, and declamation alongside the problem-solving skills that can be measured using this tool.

Evaluation can be conducted using presentation in many cases of scope as well as problem-solving skills. Rubrics are prepared to assess students' presentations, and so they are applicable both individually and in the group because they are based on crucial outcomes that demonstrate student achievements. Furthermore, each criterion in the assessment points determined in the rubric is to use to evaluate the student's learning in line with the priorities of a teacher. Therefore, it requires to given an assessment form to students at the head of activity before making a presentation to be aware of their assessment criteria.

The presentation assignment has two perspectives, including for teachers to collect information about their students' learning for making related instructional decisions, and to improve student's communication skills. Therefore, teachers should provide the following practical points to students for designing and implementing presentation assignments:

- think through the questions or challenges

- arrange and state students' perceptions

- experience new vocabulary or notation learned in a class

- demonstrate and explain what students have learned

- use and experiment with forms of argumentation

- confirm students' own opinion

- critique affirmation

- Reflect on students' own understanding and the ideas of others (NCTM, 2000).

Challenges in Applying Alternative Assessments Methods

Alternative assessment methods have several drawbacks in developing and implementing in the learning process. The methods are time-consuming to do, both to design and to work into classroom instructional time. Even teachers who are committed to the practice of performance assessment find that they don't have time to design good performance tasks, to try them out with students, and perfect them for later use. In addition, these assessments can take more time to score, since students are creating responses to them. This corroborated finding by some research found that labor-intensive and time-consuming are some of the main difficulties for alternative assessment efficient and effective implementation.

Among problems and challenges to teachers in the implementation of alternative assessment methods, is teachers' lack of familiarity with the methods, and they need expert support in the use of alternative assessment. Thus, most teachers did not have enough information about the application of Alternative assessment methods because of lack of education from the university, seminar or course, and inadequate expert support. This is consistent with findings of some research, which found that teachers did not have enough information due to the lack of education, and insufficient professional support. Therefore, many teachers have only limited experience designing such performance tasks and scoring rubrics as part of their professional preparation. And even when educators have learned such skills as part of their continuing professional growth, teachers' resistant to innovations, and they may lack the confidence to use such performance tasks as a central part of their assessment plan. Thus, it requires continuous training and development opportunities for educators, which could be costly.

The literature review indicates challenges to implementing the methods appear large. Crowded classrooms and curricular intensity are the greatest obstacles to implementation, calling for policy review and change at an institutional level. Teachers also do not have the financial resources to apply assessment complicated and many assessment methods. Furthermore, in terms of barriers, the literature demonstrates environmental challenges such as parent's negative perceptions, the pressure to teach to the test, such as Turkey, parents are understandably concerned about their children's performance on standardized tests, which can determine post-secondary choices. Moreover, student difficulties including the variety of students' behaviors, students having trouble understanding the instructions, students' negative attitudes towards those methods as barriers to implementing the alternative assessment methods.

Overcoming Challenges in Using Alternative Assessment Methods

There are several ways in which the challenges might be overcome. First, teachers very much favor the use of alternative assessment methods, such as performance tasks, self, and peer assessment. They cite these methods' ability to facilitate personal development by increasing critical thinking, creativity, and also boost student's interest and motivation towards the course, improved self-confidence, and enhanced the feeling of success. Many teachers use these methods and attest to their efficacy. However, teachers admit to needing professional development to able to appropriately implement these assessment methods.

Teachers report not being able to use these methods as often as they would like because of several factors: crowded classes, lack of time, the obligation to "teach to the test," cost and also parental resistance to new ideas, inadequate background knowledge for assessment stem from lack of education from the university, seminar or course, and inadequate expert support, variety of student behaviors, negative effects of parents, and too many methods. Thus, educators and politicians should adjust to apply the alternative assessment methods for differing classrooms or reduce the class size, enough training to teachers and the future teacher candidates how to use assessment in effective ways, provide enough materials for the teachers, proficient support through in-service courses, and attend seminars or classes that directly address the assessment methods practices. And thus, positive changes may occur in Turkey and similar countries in which have the challenges.

Second, as indicated above, alternative assessment methods are too many to implement effectively in classrooms, and for this reason, many difficulties appear. The learning process can be organized for each student, certain groups, or even for everyone according to the philosophy of possibility in this context. With this rationally, all learning activities, including learning, teaching, and evaluation related to the learning process may be changed as handled in a single and multidimensional way. Many senses can be propounded due to not existing single learning, teaching strategy, method, technique, and tactic in such a case. In the light of this philosophy, "Project-Based Performance Task" is to propose based on results of the comparison of the findings obtained from his dissertation research as a viable new alternative assessment method involving rubric, performance task, self-assessment, peer assessment, project assignment, observation, presentation and attitudes scale (Demir, 2015). Similar purposes are realizable using this assessment rubric instead of employing seven diverse alternative assessment methods. The rubric may possibly be fine as an alternative assessment method to reduce challenges raised by teachers such as teachers' workload, time-consuming, financial burden, evaluation difficulties due to class size, and the excess of assessment methods.

PROJECT BASE PERFORMANCE TASK

Name   Number   Date

_____ _____

Context of the Task:

Rubric

Instruction: *This rubric was prepared for evaluating project based base performance task. In this rubric, for each item below, please mark the box for "needs improvement" (1)" "meet expections" (2) "Above expections" (3).*

Directions	3	2	1
1. Collecting required data and information.			
2. Using appropriate procedures for the problem			
3. Analyzing the data appropriately			
4. Reaching appropriate results			
5. Using appropriate mathematical terminology, notations including labeling			
6. Solving similiar problems or responding to the relevant questions			
7. Speaking loudly and clearly			
8. Using the time effectively during the presentation.			
9. I can show all of the steps I use to solve the problem			
10. I usually give good effort on my work.			
11. I understand the topic well			
12. I enjoy doing this task.			
13. This topic attract my attention.			
14. The presentation is well organized and accurate			
15. Student is able to accurately explain the topic to classmates.			
16. He/She can answer the questions that are asked.			

Lastly, teachers may be geared to choose only an amount of alternative assessment methods for utilizing and to enlarge their exploit throughout the school year providing that a pool of alternative assessment methods are improved. This enables to both decrease the burden of evaluation administration and better located the evaluation as informatively on a subject. Marking costs could be conducted reasonably by taking into account these as opportunities for professional learning on the part of educators. By collaborating on points, teachers may sharpen their comprehensions of what high-quality learner performances seem and develop their skills to measure the extent of student

understandings of the key concepts evaluated.

Future Directions

Traditional assessment methods provide few of the higher-order skills and little of the in-depth knowledge needed for attainment in a rapidly changing and increasingly complex knowledge age. This approach does not reveal deep aspects of students' learning and enables students to explain, apply, critique, and be self-monitored. Nevertheless, the majority of countries still use basic-skills tests for assessing students in their course, choosing them for admission into academic secondary schools/universities like Turkey, England. However, accomplished learning is not able to set goals by teaching a list of facts into schools to be modified inch by inch every year. Thus, schools must assess their students using effective methods, and teach disciplinary knowledge in ways boosting the students learn how to learn to gain 21st-century skills. In this manner, the students can transmit their knowledge in recent circumstances and lead the prospects of real-world such as renewed knowledge, technology, business, and distinct social platforms.

Alternative assessment is the most recent incarnation, provides an opportunity to manifest desired learning outcomes and become distant from a teacher measurement model towards learner fortification and the enhancement of life-long learning skills (Wilson 2013:193). The assessment focuses on monitoring the learner's growth alongside improvement over a period instead of comparing the learners each other, classes or groups with one another. It aims to provide opportunities for the learners to present their comprehension of the content, and so should stimulate the development of higher-level cognitive skills that are aligned with the course purpose and intention. The learners can use alternative assessment methods to develop attitudes and skills to be fit for critical thinkers and to proceed with their learning beyond the narrow scope and time limit of a formal educational experience (Garrison & Vaughan 2008:17).

Alternative assessment methods requiring the learners to craft their own responses instead of solely choosing multiple-choice answers have started to use to match international standards. The learners are required to discover, assess, analyze, concept acquisition, systematic decision making, use knowledge in new contexts, and solve non-routine problems as well as acquiring well-developed thinking, and communication skills. These are so-called 21st-century skills that have been encouraging educators to chase for the century skills that are progressively acquired a reputation in a complex, technologically connected, and fast-changing world. By establishing a connection with the skills, the assessment methods yield a more complete picture of students' strengths and weaknesses, needs, and so the instruction can be tailored accordingly. Hence, the methods pay particular attention more directly to the improvement of students.

Instructors are aware that the 21st-century students participate in a labor market in

which they are obliged to background information according to current circumstances, analyze, synthesize, and apply them to place in new challenges, arrange solutions, coordinate effectively, and transfer convincingly. Few former generations possibly have been inquired to be fit such ingenious intellectual. Instructors acknowledge the duty to cater to their students for this new and complex world requirements. They also consider that in the current context of high risk, what is tested increasingly defines what is being taught. Traditional assessment methods, including a standardized test in general, do not gauge providing knowledge and skills gained can be applied or transferred in real-life circumstances. Instead of traditional assessment methods, using alternative assessment methods both standard and online situation enable instructors to reach targeted 21st century purposes because the alternative methods are more viable in terms of producing desirable learning outcomes.

Online Alternative Assessment

Digital tools with basically transformed the world outside of the academy cannot be ignored as long as distinct aspects of educators on the role that digital technology is situated in schooling. Those technologies are all the way bestowing new business models to firms and opportunities to enter a wide variety of markets and renew, transform the process of manufacture. The technologies can make our lives longer and healthier, bridge us over with boring duties, and enable us to travel into virtual worlds. Young students can thoroughly be prepared for 21st century social, economic, and cultural life only when they navigate through the digital panorama. For, students were able to discover only singular answers to their questions attentively from reviews and textbooks, and in general, they believed in the answers to be true in the past. Currently, they can reach multiple answers to their questions online from blogs, forums, websites, and social media and thus they do not need to wait for the right one from the already selective. For, advanced access to update digital tools offers unprecedented opportunities to them.

Artificial intelligence has shaped the whole globe; therefore schooling is not only teaching learners the content of their courses from now on but also direct them to build a reliable compass and discover navigation tools to go into their own way through an increasingly volatile, uncertain, and ambiguous world. New generation schools will require to encourage the students to think for themselves and participate with their peers with empathy and conduct their tasks in tandem. In addition, the schools will feel a need to assist the students to improve an influential perception of true and false, a comprehension of the boundaries on individual and activity by assembling, and a sensitivity to the claims that others make on them. They also will deeply require an understanding of the students' shortcomings, strengths in their learning at schools and thus integrate them into the community. For this reason, the more knowledge that technology enables students to search and access, the more significant become deep understanding and the capacity to

comprehend the content, including knowledge, concepts, ideas, and intuition as well as practical skills. However, Instructors should essentially comprise applying all of these in ways that are appropriate and integrating them into the learner's context.

Technology provides a wide range of facilities for alternative assessment methods to construct prosper and capacity of the learning experiences for primary school students alongside broadening the impact of education on societies through skills, values, and transferal of knowledge. Hence, the knowledge-based society, which is set up technology requests from teachers to make their students independent and confident learners, and motivated the students for life-long learning, teach them to learn to learn, self-directed them that might able to transfer their knowledge, skills, and merits. Influential schooling must be equivalently provided to train the primary students with these characteristics in which stimulating teachers to focus education on assessment-centered and use technology effectively from that direction. Technology-oriented alternative assessment methods are able to pay the way for both teachers and young learners to have more influence in this setting as well as gaining significant advantages to primary school students and their teachers, and policymakers in terms of progressions in teaching, learning, and high-quality knowledge level. Thus, alternative assessment methods are fairly fit to use online or through social media.

The idea of online assessment has recently been proposed, in which students assess their peers and provides feedback, and opportunities for assessment, and autonomy through online collaboration. Through combining internet and alternative assessment, learners can more interact with each other, comment on their peers' work, engage in more, and share perceptions about various issues. What is more, the online assessment provides better opportunities for learning and evaluation than traditional methods, and it can be more efficient than in a traditional classroom setting for a new generation and reduce the cost associated with brick and mortar education. The online assessment also allows instructors to monitor the progress of students and the activities more closely. Advantages include making the teachers' job more manageable in crowded classrooms, time and cost-effectiveness, and the creation of an environment where students can provide feedback to their peers and activities much better without being limited by time and place. Additionally, this assessment process provides students with the opportunity to freely interact, submit, store, review, and revise the assignments whenever and wherever they are, as well as allowing students to monitor, track, and discuss revisions of their duties.

Alternative Assessment through Social Media

Social learning theory is based on the idea that much cognitive learning occurs through social interaction (Fahim and Mehrgan 2012; Vygotsky 1978). According to social

learning theory, learning occurs through interpersonal interaction, acts or performance, and environment. Thus, social interaction is one of the most powerful tools for learning and skills development, leading to new ways of co-constructing ideas. Social networking serves the three broad functions of socializing, sharing, and participating in an e-learning context. Social networking tools that have the potential to fulfill all of these functions emerged.

The fact that social media specifically is so frequently used, especially by younger people, suggests the value of its inclusion as a significant component in the educational curriculum, and given students' familiarity with this tool, the sooner the better. In order to extend the communicative activities of the traditional physical classroom to a virtual form, Facebook can also be served as a tool for instructors to connect, befriend, and communicate with students. In addition, university students are able to use Facebook to facilitate their academic goals, and it is a tool and platform that "enhance communication and interaction can potentially be used for learning" (Godwin-Jones 2008, p. 7)

The rapid increase in the utilization of online learning environments and social network sites, such as Facebook, Instagram, Tik-Tok, Twitter, and LinkedIn, offers additional potential for the pedagogical use of some of the alternative assessment methods such as self-assessment, peer assessment through feedback. These websites have impacted education and changed the landscape of the learning process by enhancing pedagogical interaction. It was also asserted that using websites enables students to communicate and do various course assignments. Currently, students demand greater autonomy in their own learning to create new insights and share their ideas with peers, teachers. Some of the social media tools, including Facebook, Instagram, etc. are one the appropriate and widely used social network site for these functions to provide many pedagogical benefits. Therefore, in this study, social media is recommended to use as a learning tool to provide feedback, interaction, social communication and actively assess one another. Students are ready for the prospect of using social media to support classroom assignments to ask and answer questions, post their comments, support their peers in educational activities, and discuss their tasks. These interactions may have an influence on fostering student-student and teacher-student interaction for feedback, in particular assessment-centered learning, and may be useful to both students and teachers since peers are available online.

Development of internet technologies and widespread use of social networking sites has led to increased use of online assessment in classroom settings, "having positively affected student assessment processes" (Lu and Zhang 2012, p. 317). On the one hand, social sites "facilitate collaboration and offer the potential to move away from the assessment of individual skills to implement a social constructive view of learning" (Whitelock 2011, p. 320). On the other hand, the online assessment has a number of advantages, such as assignment submission, storage, communication, and review, over

face-to-face assessment High Educ. It also enables learners to interact and communicate with peers and teachers to revise their work based on feedback when and where they like, and can increase the willingness of students to engage in the assessment.

Social networking sites allow for knowledge-building and support educational activities in terms of information and resource-sharing. Using social media platforms also enables students to work on various course assignments together and assess each other. Thus, it is necessary to consider the affordability and potential value of these sites for learners in education. Using the sites in educational and instructional contexts can be a powerful tool as most students spend a great deal of time connected to social networking sites, but further study is needed to reveal the specific mechanisms by which social networking sites influence learning and assessment (Pempek et al. 2009).

Conclusion

The literature review indicates that there are several recent studies have focused on using some alternative assessment through online and social media in the education context (Demir, 2018; Deng and Tavares 2013; Shaltry et al. 2013; Li and Law 2012). For instance, the research indicated their study on the effects of online peer assessment, in form of peer grading and peer feedback, on the students' learning. The results show that the provision by student assessors of feedback that identified problems and gave suggestions was a significant predictor of the performance of the assessors themselves and that positive affective feedback was related to the performance of assesses.

Integrating online assessment and Facebook might create a more effective learning process, enable students with an environment to express freely their ideas about their friends' work, and provide learners with opportunities to evaluate their peers effectively. I highly recommend using some of the usable social media tools like Facebook and Instagram because they are considered as the well-known social network among youth students in primary school and High Education. For instance, in my university classes, it is not uncommon for student teachers to covertly check their Facebook accounts right in the middle of a lesson, and my experience is not unusual

Education has won the race with technology throughout history, but there is no guarantee that it will do so in the future (PISA, 2018). On the contrary, from my point of view, technology is one step ahead at present, and if digital tools are not rapidly integrated into schooling, the winner of the race will always be technology, and so education will always be in the background. I assumed that using online alternative assessment methods or compound social media as a learning tool with online alternative assessment methods could facilitate and constitute the interactions among students that occur inside and outside of the classroom that can prove to have pedagogical values. Accordingly, teachers have been encouraged to prepare their students for 21st-century skills that are

progressively acquired a reputation in a complex, technologically connected, and fast-changing world. It also makes education leader again and leads the way of the life.

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About the Authors

"Mehmet DEMIR, Ph.D., working as an Assistant Profesor in the Department of Teacher Education at The University of Birmingham currently. He earned his Ph.D. and Master's degree in Education Sciences-Curriculum and Instruction from the University of Inonu, Turkey in 2015 and 2010 respectively. He worked as a research assistant at Adiyaman University. He was a visiting scholar at the University of Pittsburgh in the School of Education's Collaborative for Evaluation and Assessment Capacity (CEAC), PA, United States. He was actively involved in many projects› data collection, analysis and reporting. He also worked as a Research Assistant at The School of Education University of Pittsburgh. His research interest includes curriculum evaluation, assessment on math, alternative assessment, and online assessment through Social media. In the past, Dr. Demir worked as a principal and assistant principal for two years and taught for five years at different elementary schools.» m.demir@bham.ac.uk

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Digital Assessment Tool: E-Portfolio

Bilge Gok
Hacettepe University

Mahmut Ayaz
Hacettepe University

Portfolio is one of the alternative assessment approaches commonly used in education today. A portfolio is a product file, a skill set or a knowledge base that is kept in a certain period of time, which includes the picture, sketch, poem, story, project or academic writings that a student has prepared and shows the level of development. Portfolio is a performance measure in which the student creates the content according to himself and allows him to organize in a way that he can improve on a certain skill set. It can also be used as an assessment method to measure a student's progress in a certain subject in a certain period of time (Filkins, 2010). Portfolio represents the whole of the work done at the end of a certain process (Larson, 2003). Portfolios can be defined as product files in which students display their work and achievements throughout the process (Paulsen & Meyer, 1991). As stated by Chen and Mazow (2002), a portfolio is a collection that shows a student's progress, efforts and achievements in one or more areas.

Guskey (2003) and Ada, Tanberkan Suna, Elkonca and Karakaya (2016) define portfolio as an evaluation tool that brings together the process and product, where both the learning process and the learning product are important. In the process of creating portfolios, students can choose and evaluate their own learning products (Barrett, 1998). In addition, portfolios are not only a learning method but also an opportunity for evaluation (Wiggins, 2004). Many researchers (Gibson, 2006; Guskey, 2003; Karakaya, 2015; Stevenson, 2006) explained the features of portfolio evaluation as follows: They state that portfolios are folders where systematic, purposeful and meaningful student collections are collected in one or more subject areas. On the other hand, Barrett (1998) described a portfolio as a curriculum vitae whose contents could be defined by the student or teacher, a representative example of overall performance, or an ever-changing exhibition, with a primary focus on documentation or assessment. Gibson (2006), emphasizing the learning process, defines a portfolio as a record of a student's learning process: How the students learns and progresses in learning, how they think, question, analyze, synthesize, produce, create, and interact with the their friends and teachers intellectually and emphasizes that they are a record of how they interact emotionally and socially. Simon and Forgette Giroux (2000) and Karakaya (2015) define a portfolio as a systematic accumulation of a student's development in an area, recommended by teachers or peers. In addition, Birgin (2002) defines portfolio evaluation as the collection

of skills in one or more areas obtained through regular accumulation and the evaluation of evidence according to predetermined criteria. As a result, a portfolio is a purposeful collection of studies that show the student's development in the learning process, student efforts and academic success. By using portfolio, the teacher's aim monitors the student's development process; allows the student to monitor his/her own development process; documents student learning outcomes; gives feedback to parents, teachers and students about the student's learning outcomes; provides information about the student for the following years and enables the student to make self-assessment. In this way, the portfolio gives clues about the learning style of the student (Lambdin & Walker, 1994).

Johns (1995) explains the general characteristics of the portfolio as follows:

1. Portfolios are product files and represent students' work over time.

2. Portfolios represent the evaluation objectives of a program.

3. The products selected in the portfolio are chosen for certain purposes.

4. Portfolio products are collected over a period of time; so that students, parents, administrators and teachers can play a role in the evaluation process.

5. Portfolios include students' work, tasks and strategies for approaching them, and reflections on input that encourages assessment.

Advantages of Portfolio

The use of portfolio provides many advantages to the student. The collection and evaluation of the products in the portfolio by the student motivates the student. Engel (1996) stated that portfolios improve students' self-expression skills and contribute to the development of reflective thinking skills. Portfolios, under the guidance of the teacher, include placing the student's chosen work in his/her file; thus portfolios put the student in charge of learning and develop the student's creativity. Portfoli aims to develop the student as a whole, rather than which student knows more as in the classical assessment. The answer is sought for what the student knows (Morgil, Cingör, Erökten, Yavuz, & Özyalçin Oskay, 2004).

Engel (1996) states that many students cannot express themselves fully in schools, and portfolios allow students to express themselves. The portfolio develops students' feelings of curiosity and confidence, and provides opportunities for evaluation and expression. These are sources of energy not only for learning at school, but also for lifelong learning. Portfolios can capture and reveal meaningful aspects of individual life. When teachers examine portfolios with children, they can observe that they are indeed using new tools for teaching and that the portfolios used add a different dimension to teaching. By adding

a different dimension to teaching, portfolios develop students' active, creative, energetic, constructive and meaningful mental processes. Strijbos, Meeus, and Libotton (2007) stated that portfolio assessment is a tool that can be used to increase students' general thinking capacity. According to Grady (1996) and Melograno (1996), the advantages of portfolios are: 1) Providing the student with a wide range of study opportunities on a particular subject, 2) Helping students to set goals and providing self-evaluation, 3) Allowing students to progress according to their differences, 4) Allowing peer assessment 5) Focusing on the student's effort and success and improving students in many ways, 6) Allowing association with learning in the assessment and teaching process, 7) Focusing on real student work, not on predictions provided by a score on a standard test, 8) Presenting an effective learning process.

When the literature is examined, it can be said that portfolios contribute to the development of students' reflective thinking, self-evaluation and critical analysis skills (Berrill & Whalen, 2007; De Jager, 2019; Samaras & Fox, 2013). According to Huang (2006), the portfolio evaluation process contributes to the development of students' reflective skills and encourages communication by increasing cooperation among teachers.

Limitations of the Portfolio

The limitations of the portfolio are as follows (Haladyna, 1997; cited by Kutlu, Doğan, & Karakaya, 2014):

1. **Originality for the Student:** The portfolio should consist of the works prepared by the student. However, the student can get help from different sources or people around him during the portfolio preparation process. Therefore, it is difficult to say that the portfolio is prepared entirely by the student. It can be said that this situation negatively affects the validity and reliability of the teacher while scoring the portfolio.

2. **Honesty:** While the portfolio is being prepared during the teaching process, the student can present the portfolio as if he/she prepared it without doing it. The probability of cheating during the preparation of the portfolio is very high. This negatively affects the development process of the student. In order to prevent this, it is important that teachers provide an environment for students to prepare their portfolios and reward students' honesty.

3. **Efficiency:** Both the portfolio preparation and evaluation process are very time consuming. This negatively affects the scoring of the portfolio.

4. **Archiving Student Work:** Archiving student portfolios is the responsibility of teachers and school administration. It is extremely important that student

portfolios are properly stored.

5. **Lack of objectivity (rater inconsistencies, bias):** It is very difficult to objectively score higher-order thinking skills. Objectivity in scoring can be achieved by using a rubric.

6. **Reliability:** It is important to use a rubric to ensure the reliability of the portfolios prepared. For this reason, the rubric should be prepared in a way that makes detailed scoring.

Portfolio Types

In June 1987, the San Diego Professional Development Consortium project gave birth to the concept of professional development portfolio and the professional development portfolio was accepted as a combination of three types of portfolios (Kan, 2007): These are a presentation portfolio, a work portfolio, and a student portfolio. A presentations portfolio shows an individual's achievements, learnings, strengths, and expertise. A work portfolio has been defined as a collection of assignments, works, and other evidence that fulfills prescribed competencies, standards or outcomes. The student portfolio is expressed as a reflection of the knowledge, experience and emotions that will allow the student to define specific learning outcomes. A professional development portfolio should be based on four characteristics: These are purpose, focus, process and results. At this point, students clarify their goals, define their core values and belief systems, focus on their interests and students make a plan for collaboration, learning and reflection, and also prepare "exhibits that define learning" (Piper, 1999).

According to Smith and Tilemma (2006), the purpose of the portfolio determines the type of portfolio created. There are four basic types of portfolios:

1. Dossier portfolio

2. Training portfolio

3. Reflective portfolio

4. Personal development portfolio

Dossier portfolios are portfolios that showcase the student's best work. Both the teacher and the student decide on the work to be selected in the portfolio. Typically, a training portfolio highlights work that demonstrates the professional knowledge, skills or competences achieved. On the other hand, a reflective portfolio is voluntarily prepared by individuals to prove one's own achievements and help them evaluate their own progress. Another common classification is documentation, process and show case portfolio types

(Prince George's Country Public Schools, 2004; cited by Demirli, 2007: 20).

Documentation portfolios: It is defined as a work or work portfolio. In these portfolios, all the works done by the students with or without purpose and the studies that show their development over time are collected.

Process portfolios: All the work done by the student during the learning process can be found here. In this portfolio, students are included in the learning process and in this process, the student is given the opportunity to reflect the learning experience.

Show case portfolios: Portfolios that showcase the best work done by the student. Both the teacher and the student decide together on the work selected in the portfolio. In addition to all these, Rolheiser, Bower, and Stevahn (2000) mention two types of portfolios and these are best reflect work and growth portfolio. The best work portfolios: In fact, they are also known as presentation and showcase. It generally contains the most important and most noted works. It also covers the process of coming up with these best works. Students explain why they are able to transfer their higher learning reflections to these studies and that these studies are the result of their efforts and achievements. Portfolios reflecting progress are portfolios in which the student evaluates himself/herself in line with the goals and monitors his/her success, and shows the status of personal development over time. Today, with the advancement of technology, computers are used as an effective tool for developing and storing portfolios, as they can both store large amounts of content and effectively support and guide the portfolio process. The electronic version of the portfolios is useful, economical, has storage and transfer features, and also aims to help the use of technology.

Electronic Portfolio (E-portfolio)

Until the 1990s, while paper portfolios were preferred for preserving students' studies and the products obtained as a result of learning (Lorenzo & Ittelson, 2005), with the development of technology, students' works are prepared in electronic format and online. This is cost-effective, easy to share, portable, accessible from anywhere with an internet connection, visible to anyone who is given access to them (in the case of a portfolio that requires a password), almost indelible, and a quick assessment tool for the teacher (Thomas et al., 2001).

With the increase in the use of information and communication technology in the education system, it can be said that the use of the electronic version of the portfolio, which is called e-portfolio, web-based portfolio or digital portfolio instead of portfolio, has become widespread both in teaching and as a complementary assessment tool. E-portfolios can present documents in formats such as pictures, graphics, videos and texts by making use of multimedia, as well as having all the features of traditional paper-

based portfolios. Therefore, it can be said that they have a great advantage in terms of both enriching the activities and providing convenience. The most distinctive difference of e-portfolios from paper portfolios is that they are completely online. In e-portfolios, as in paper portfolios, the presentation is not only in the form of printing, but can offer multiple options to the user. Therefore, e-portfolio developers are free to create a variety of formats, including audio, text, graphics, video and multimedia, rather than being limited to one connector. The large number of software applications available today offer the opportunity to create virtually any type of artifact digitally in portfolio creation. Traditional paper portfolios have always met teacher assessment requirements and have typically been used as a tool to understand and monitor students' progress. However, looking at the practices, teachers usually decide for themselves which works will be placed in the portfolio and which will be passed on to the next teacher. E-portfolios, on the other hand, allow students and teachers to work collaboratively on the skills and requirements of the project (Ada, Tanberkan Suna, Elkonca, & Karakaya, 2016). As a result, the e-portfolio offers various benefits such as what a regular portfolio should look like and what students should do during the learning process. E-portfolios can take different forms, including software-based portfolios, CD-ROM-based portfolios, and Internet-based portfolios. Due to usability and prevalence, internet-based portfolios are preferred more. These are also called web-based portfolios and more recently known as blogs.

Thomas, Lamson, and King (2001) defined e-portfolios as a collection of works and reflective statements in electronic format that show the progress in students' professional and intellectual competences. On the other hand, MacDonald, Liu, Lowell, Tsai, and Lohr (2004) define e-potfolios as multimedia environments that show the reflective thinking of students and works that show document professional growth and student competencies. Barrett (2007) defines an e-portfolio as "a collection of original and diverse evidence drawn from a larger archive that represents what an individual or organization represents and is designed for presentation to one or more audiences for a specific purpose".

E-portfolios give teachers the opportunity to learn about the interests of their students and to monitor their individual development processes. E-portfolios offer teachers and students the opportunity to learn and apply the latest technology used in education (Cassiano, 1999). An e-portfolio is an electronic filing format chosen to demonstrate the progress of student learning over a semester. An e-portfolio file may contain many works such as photography, video, research projects, interviews and reflective writings (Carl & Strydom, 2017).

The e-portfolio system is a web-based software system with digital storage features that can be accessed via the World Wide Web. Traditional e-portfolio systems in education include Google Apps, Mahara Systems, WordPress, Blogger, LiveBinders, Weebly,

PebblePad, and Canvas. The first of the most important technological features of an e-portfolio system is the display of the work done, and the second is the learner's ability to easily change the collected content to achieve different goals. These technological features are indisputably mandatory components of any e-portfolio system, as they help the student document the prepared content and share their personal and professional development.

The advancement of information and communication technologies in recent years has contributed to the increase of using of technology in education. At the same time, e-portfolio, one of the technologies used in education, offered innovative and creative ways to support students' learning. The main purpose of using e-portfolio is to enable students to document their personal development (San Jose, 2017). The e-portfolio is not only a work product file, but also a space and tool that can be used to support individual learning and competences (Barrett, 2007).

Because the e-portfolio is online, it is easy to access. An e-portfolio usually includes a series of web pages that organize and contain the user's work (Kimball, 2003). In the use of e portfolio, first of all, a home page comes to the front of the user. The main page of the e-portfolio contains links to the content. Thanks to these links, the e-portfolio user can easily navigate through the site and examine the works that make up the content of the e-portfolio.

An e-portfolio is not a haphazard collection of works, but a neatly organized collection of works that represent a guided purpose. Works are supported by written narratives that reflect the work within the portfolio and how it relates to its purpose. The structure of the e-portfolio should be developed before starting the selection of works. Heath (2004) states that the e-portfolio is not only a collection of works, but also has the purpose of showing the knowledge and skills of the creator. The purpose of the e-portfolio is to show the creator's improvement in the knowledge and skills over time.

Kahtani (1999) recommends that students create e-portfolios because it is difficult and time consuming to find product files or portfolios kept in different places. On the other hand, Heath (2002) argues that after the portfolio is transferred to electronic environment, it is easier to maintain, edit and update it than paper samples. In addition, in e-portfolios, the work of students can be collected, stored and managed electronically using very little physical space (Ayaz, 2021). E-portfolios are electronic collections that represent an individual's level of knowledge or work status in general terms (Heath, 2005). The works in this collection are work pieces that show the development of a person's skills in a certain time period (Ada, Tanberkan Suna, Elkonca, & Karakaya, 2016). These can be reports, assessments, essays, digital pieces, audio and conceptual tools.

The student's learning objectives in completing the e-portfolio are:

- The student understands that it is important to respect the students they collaborate with when creating performance-based projects.

- The student expresses his/her thoughts on a topic clearly and consistently while using technology during learning process.

- The student comprehends and applies programs such as HyperStudio and Portfolio Evaluation Toolkit to create a portfolio (Cassiano, 1999)

Advantages of E-Portfolio

In general, portfolios lead students to think critically about their own developmental processes and encourage students to take responsibility for their own learning through self-assessment (Harring & Luo, 2016; Krause, 1996; Sata & Karakaya, 2020). Since the portfolios created are in electronic version, they encourage students to learn about electronic resources and emerging technologies (Lorenzo & Ittelson, 2005). With the increase in the use of technology in education, its use in different fields has become widespread. E-portfolios allow students to evaluate their skills with computers and other technology devices. In addition, since designing e-portfolios requires a creative approach, it improves students' creativity (Ayaz, 2021). Another benefit of using eportfolio is that it increases the teacher-student interaction in the learning environment, provides the student with an individual learning experience and provides a natural environment for the individualization of their goals (Stoddart, 2006).

Cohen (2005) stated that the use of e-portfolio in education will provide teachers with the following advantages:

1. Contributing to the observation of a student's development process over time.

2. Providing each student with the necessary information to develop a program in line with their own learning.

3. Enabling students to participate in the creation of portfolios that help them understand their own strengths and weaknesses.

4. Ensuring that a strong communication method is used. (Teachers, parents, children and other family members can play a role in creating and reviewing the portfolio).

The e-portfolio is used not only as a means of assessing students' knowledge and skills, but also as a learning tool. Teachers can effectively assess students' skills and learning progress by using the e-portfolio. Oehlman, Haegar, Clarkston, and Banks (2016) stated that an e-portfolio supports reflective learning, facilitates the transfer of knowledge, and actively engages students who are not active enough in the course. Hawisher and Selfe

(1997) listed the benefits of e-portfolios to students as follows: First, students will attach importance to the product creation process and therefore their learning motivation will increase. Because e-portfolios will enrich students' work by using various multimedia tools and will enable them to share their work more easily. Second, e-portfolios are both more portable and require less physical storage space than paper portfolios. Third, creating an e-portfolio can be seen not only as textual literacy using technological tools, but also as a form of web pages that students can design according to themselves.

E-portfolios are generally committed to the integration of various purposes such as reflective thinking, deep learning, student assessment and grading, career and curriculum vitae planning, program evaluation, academic counseling, curriculum planning, course evaluations, tenure decisions, institutional evaluations, and so on. (Stewart, 2018). Paper-based portfolios, like e-portfolios, although they encourage learning, do not provide as many advantages as e-portfolios. Although different versions of portfolios encourage learning, the use of e-portfolios is more common for some reasons. Common reasons for using e-portfolios include easy portability and remote access. E-portfolios provide a digital platform where data can be stored quickly and accessed quickly (Atasoy, Somyürek, & Karakaya, 2018; Barrett, 2007; Gülen, 2020).

With the e-portfolio, students have the opportunity to store the products they prepared during the teaching process on the web, to evaluate their own work, to share their work with their friends, and to evaluate the work of their friends (Atasoy, Somyürek, & Kara-kaya, 2018).

Limitations of the E-Portfolio

Although e-portfolio has some advantages over paper portfolios in using or preparing it, it also has some limitations in terms of usage and technique. Some limitations of e-portfolios are grouped under the following titles (Alan, 2014; Montgomery and Wiley, 2008; Sata and Karakaya, 2020; Van Wesel and Prop, 2008):

Requirement of technical equipment: It is necessary to have different technological tools (such as hard disk, scanner, computer, video recorder) in order to transfer the prepared portfolios to electronic media.

Requires technical skills: In order to prepare a portfolio and transfer it to electronic media, it is necessary to have the ability to use some technological tools (such as computer, software) and to have technical equipment to eliminate technical malfunctions in some technological tools (such as voice recorder, video recorder).

Requirement of internet: It is very important to have the internet in the e-portfolio application process. Because the portfolio application process and the interaction in the

application process are provided via the internet.

The difficulty of protecting personal information: The e-portfolio application is a system open to everyone. This makes it difficult to protect information about students. Therefore, private information about the student should be protected so that it is not shared in the portfolio.

High cost requirement: E-portfolio systems are more costly than paper portfolios because they require some technological tools (scanner, computer, video recorder, internet, webcam, etc.).

Proderick (1998) expressed the difficulties in developing e-portfolios as follows:

1. Lack of software, hardware and personnel training,

2. Teachers' lack of technological competence and hardware support.

Conclusion

When the studies on the e-portfolio are examined, it is seen that many studies have been carried out by different researchers at different levels in Turkey and abroad (Goeman, 2007; Huang, Yang & Chang, 2011; Polat-Demir, 2020; Barrot, 2016; Chang, Liang, Chou & Liao, 2018; Gök, Baş & Ayaz, 2020; Gülbahar & Köse, 2006; Ayaz, 2021). It has been observed that a significant part of the studies on e-portfolio have revealed the effect of students on their academic achievement in a learning area. Studies have revealed that the evaluation of the e-portfolio provides more feedback to the students and teachers than the evaluation made with traditional methods and the e-portfolio supports the students in giving the responsibility of learning to the student and keeps the student more active in the process, and increases the communication between the student-parent-teacher. The researches were carried out mostly in the form of experimental studies. Studies have focused on basic skills (reading, writing, speaking), thinking skills and personal characteristics (association, socialization, responsibility) rather than lifelong learning skills, and mostly undergraduate studies have been conducted. It has been observed that studies on thinking skills (critical thinking, creative thinking and reflective thinking) are relatively few in the literature. it was concluded that e-portfolio applications contributed to the development of these skills according to the findings obtained in these studies.

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About Authors

Bilge Gok is an Associate Professor, Faculty of Education, Department of Primary Education at Hacettepe University, Turkey. Her research interests include issues such as test and scale development, scale adaptation, national and international exams, educational measurement and assessment practices in education (especially in-classroom assessment practices). She has conducted numerous studies concerning national and international exams, scale development, measuring cognitive and affective characteristics. She has a background in educational measurement and evaluation. E-mail: bilgeb@hacettepe.edu.tr, ORCID ID: 0000-0002-1548-164X

Mahmut Ayaz is a doctor who works as a teacher at a school at the Ministry of Education. He earned his PhD in the elemantary education depertment of Hacettepe University in Ankara. He works in areas such as measurement and assessment in primary education. E-mail: mahmutzaya@hotmail.com, ORCID ID: 0000-0001-9010-0002

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SECTION 6
STEM EDUCATION

Argumentation Integrated STEM Activity

Salih Gulen
Muş Alparslan University

Introduction

Science has a wide range of subjects. Due to the fact that these subjects are spread over a wide area and there are difficulties in learning, different alternatives are sought. Approaches such as Toulmin's argumentation model and STEM education can be used in learning sciences. Constructing knowledge using discussion and principles within STEM disciplines suggests that learning will be effective. Therefore, various integrations have been foreseen in order to increase learning in science subjects to a higher level. The integration of the Toulmin argumentation model and the STEM education approach is one of them. Below, first the Toulmin argumentation model, then STEM education, and then the theoretical infrastructure for integrating the two are discussed. Finally, it is aimed to facilitate the understanding of the subject with examples and sample activities.

Argument and Argumentation

Before the concept of argumentation, the concept of argument needs to be defined. Argument is the product of an individual in defending his claims and opinions with evidence. Argumentation, on the other hand, is defined as the process of creating an argument. Although argumentation is seen as a high-level thinking ability of the mind (Scheuer, Loll, Pinkwart, & Mclaren, 2010) for ancient philosophers, it has been explained as a claim and accompanying justification for Toulmin (1958). Argumentation in general; defines a scientific phenomenon as a process that includes both cognitive and social dynamics, involving scientific discussions, in which individuals evaluate, criticize, analyze and provide evidence for explanations verbally or in writing (Aydın & Kaptan, 2014; Simon, Erduran & Osborne , 2006).

Toulmin is determined to be one of the pioneers of informal logic and rhetorical theory today who born in London-England in 1922. He stated that his book "The Uses of Argument", published in 1958, is a model of argument for the analysis of rhetorical arguments. Creating a model consisting of six items, Toulmin also showed that there is a relationship between the items (Aldağ, 2006). According to Toulmin, logical ordinary arguments against a "narrow" approach can be a serious reaction. He noted that the application of these arguments is present in daily life conversations among the public rather than advocates in the legal field. According to Toulmin, each element in the argumentation process will be used in the logical interpretation and judgment of the data. In addition, it is stated that these elements can be used in both experimental and non-

experimental creative and logical calculations, targeting a broad approach. Toulmin's research on light, based on his logical examples, and as a result of this research, comments were made about the argument that emerged with logical knowledge (Zarębski, 2009). In addition, as Toulmin pointed out, he stated that creating an argument is effective even in choosing one of two different objects in daily life, as well as discussions. It is explained that the arguments for beliefs and options should be formed and the principles of decision making and the right options should be determined. In addition, it was stated that the arguments created should have clear goals, as they may be exposed to external threats (Amgoud & Prade, 2009).

Toulmin Argumentation Model

Toulmin focused on discussion and philosophy in his studies in order to form the logic of argument and argumentation. Toulmin defines discussion as an interactive and dynamic process that takes place in such a way that the testing of ideas, the assertions and the evidence, create a social meaning. In the model created by Toulmin (Figure 1); mentions three basic elements (claim, data and warrant). Three more auxiliary elements (backing, qualifier and rejecter (rebuttal)) are used to reinforce these elements. In addition, Toulmin states, changes can be made in the model by adding auxiliary elements when necessary during the process of structuring the knowledge (Akkus, Gunel, & Hand, 2007).

In this model, the claim is the opinion or explanation put forward for the solution of the existing problem. The data includes the facts or observations used to support the claim. The warrant is the reasons for supporting the claim. Backing is examples given to strengthen the warrant. The qualifier indicates the positive aspects of the claim, and the rejecter (rebuttal) indicates the negative aspects of the claim (Simon, Erduran, & Osborne, 2006; Tümay & Köseoğlu, 2011).
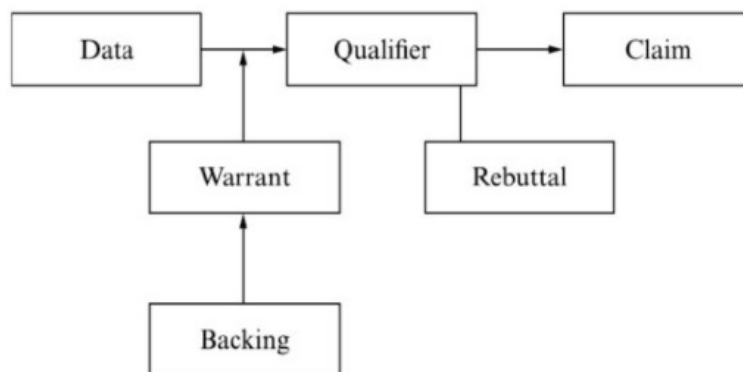

Figure 1. Toulmin's Argumentation Model

The following example can be used to better understand the concepts in the model. If we examine the Ali version of the "Harry" example that Toulmin gives in his studies:

Data: Ali was born in Ankara.

Claim: Ali is Turk.

Warrant: Those born in Ankara become Turkish.

Support (backing): Ankara is Turkey's land.

Qualifier: Those born in this city are Turkish.

Rejecter: If his parent is foreign, he is not Turkish.

When the example of Ali is examined, it is understood that in Toulmin's argumentation logic, the claim is formed based on data and warrant, and this claim is emphasized with supporting, qualifying and rejecting elements. Similarly, when the cigarette example is examined:

Data: Smoking causes serious inconveniences to human health.

Claim: Smoking is harmful.

Warrant: Smoking damages the lungs.

Support: If you smoke, you cough because your lungs are damaged.

Qualifier: My father coughs constantly

Rejecter: Cigarette smoke can kill some harmful bacteria in the body.

Toulmin argumentation model stages are seen in the example of cigarettes, as in the example of Ali. The biggest factor between these two examples is the origin of the claim. As a matter of fact, while the claim is "positive" in the case of Ali, it is seen that the claim is "negative" in the example of cigarettes. These are extremely common. However, it should be noted that when the claim is positive, the qualifier is also positive, but the rejecter is negative. On the contrary, when the claim is negative, the qualifier is also negative, but the rejecter is positive (Amgoud & Kaci, 2006; Scheuer et al., 2010). Now, when we consider both cases with a different example, the following table data can emerge.

Table 1. Example of Toulmin Argumentation Model

Data	Within the scope of the science course, Ceylin and Erva take the task of constructing a simple electrical circuit with the electrical circuit elements given to them. Ceylin uses a battery, a switch and two light bulbs in a simple electrical circuit. Ceylin, who created the electrical circuit with the help of conductors, observed that the bulbs gave light when the switch was closed. Meanwhile, Erva, using the conductor in her hand, added a connection that will divide the circuit into two with the light bulbs on one side and the switch on one side and the battery on the other. It was observed that the bulbs did not light even though the switch was closed at this time.	
Claim	Ceylin knows how to set up an electrical circuit.	Erva does not know how to set up an electrical circuit
Warant	The bulb gave light because it connected the conductor and circuit elements correctly.	If she knew how to connect conductors and circuit elements, the bulb would light like Ceylin's circuit.
Support	In the electrical circuit, the power source and the light bulb must be connected to the same conductor. A "short circuit" happens when another conductor is added in between.	If the conductor is connected with the bulbs on one side and the battery on the other, the circuit is "short-circuited".
Qualifier	Ceylin gets high grades.	Erva gets low grades.
Rejecter	Ceylin's success may be accidental.	By making mistakes, she can reach the right result by trial and error.

When Table 1 is examined, examples of positive and negative claims that can be obtained from the data are presented. Accordingly, only two of the claims that may occur in the Ceylin-Erva event are included. In fact, in this example, it is emphasized that the variety of claims may increase. Therefore, it should be known that the arguments created using claims and elements should be based on scientific data. In addition, the arguments used in proving the claim are important here. Evidence needs to be supported by scientific data (Gülen, 2020; Tsai, 2018). Toulmin's argumentation approach is an application approach that aims to prove his claims made in the light of data (Gülen, 2018). Although there are slight differences between applications, similar steps are generally used (Hall & Sampson, 2009; Sampson & Gleim, 2009). The purpose of this approach is to create the claim from the data, present the claim together with the evidence and support it in the relevant discussions during the argument creation process.

STEM Education

Director of the US National Science Foundation, Dr. Judith Ramaley pioneered the name of the Foundation's integration of Science-Technology-Engineering and Mathematics as STEM for the first time in 2001 (Gülen, 2016; Zouda, 2018). STEM, which emerged as a result of scientific studies and social needs, is an educational approach that is accepted as the new trend of education in the international arena. This approach arose from the competition in international scientific mobility (Ayaz, Gülen, & Gök, 2020; Honey, Pearson, & Schweingruber, 2014).

Increasing economic and scientific developments have caused many countries to compete in the international arena. Countries have turned to education policies in order to be successful in this competition. After Japan's success in every field since the eighties, a similar success came from China, especially the USA aimed to renew its education system in order to achieve the same success. The USA has started to reform education in order to have qualified engineers and workers (Aydeniz et al., 2015). The STEM approach, which has come to the fore as a state policy in the United States since the 2010s, has made a rapid exit with the budget allocated to it. First of all, it was ensured that the growth of STEM business areas was determined and the business world focused on this area with the agreements made with the private sector. The newly opened schools stand out as schools where innovative pedagogies such as project-based learning and engineering design process are applied (Dönmez, 2020; U.S. Department of Education, 2015). With this mobility, it is aimed to obtain employees who have developed metacognitive thinking skills and trained in different disciplines in the business world. Currently, courses such as neurobiology, robotics, microelectronics, bionanotechnology, DNA science, advanced astronomy data and physics laboratory are taught in these schools (Drew, 2011; Pierson, Brady, & Clark, 2020). The situation in the USA is also seen in European countries. Rocard et al. (2007) stated the importance of STEM education in European Union countries in the report titled "Science education now: A new pedagogy for the future of Europe". In the report, the importance of education of science subjects, especially teachers, for the future of countries, was discussed with a social support. Another noteworthy factor here is the perspective of STEM disciplines and the provision of gender balance in vocational acquisition. For this purpose, with the realization of the 7th Framework between 2007-2013 and the HORIZON 2020 programs between 2014-2020, actions for STEM education emerged (Honey, Pearson, & Schweingruber, 2014; MoNE, 2018; Tzu-Ling, 2019).

Studies on STEM education in Turkey were first carried out at Istanbul Aydın University and Hacettepe University. Especially the STEM education laboratory established in Hacettepe University in 2014 has started to make an important contribution to the studies in this field (Aydeniz et al., 2015). In addition, since similar years, the Ministry

of National Education has pioneered the official dissemination of STEM education in the national education community by organizing STEM education seminars and activities to introduce STEM materials to the teachers of pilot schools (Gülen, 2016). Particularly, the recent workshops and symposiums on STEM education by various universities in Turkey affect the promotion of this field. In addition, there are studies to increase incentives for STEM fields in accordance with the vision 2023 policy of both the Ministry of National Education and the Higher Education Institution (Dönmez, 2020). Basically, the targets related to STEM disciplines and their uses in our country's vision 2023 policy are given below.

1. To increase interest in STEM disciplines from an early age,

2. To guide young people to choose STEM disciplines as a career through vocational guidance and counseling activities,

3. To ensure gender balance among students in STEM fields,

4. To train enough and qualified teachers in STEM courses,

5. To increase the intake of scientific and technical courses in secondary education programs,

6. Schools directing students to choose STEM courses and increasing their status in teaching these courses,

7. To provide the infrastructure of STEM disciplines in higher education, to establish education and research laboratories in all disciplines,

8. To make productions in all STEM areas of the country and to ensure that products are an important export item until 2023,

9. To ensure that every individual in the country receives STEM education and to become technical personnel who can work at home, at work and in the industry as qualified individuals in the society.

The said vision 2023 policy will be evaluated with the increase in the number of indicators and targets resulting from STEM education (Dönmez & Gülen, 2021; Gülen, 2020).

STEM Education Aims

STEM education; It aims for every member of the society to do practical training with their family or friends anytime and anywhere as a hobby or professional (National Recearch Council (NRC), 2015). One of the primary aims of STEM education is to ensure that individuals who make up the society have 21st century skills. These skills are;

Learning Skills (such as creative thinking, critical thinking, reflective thinking, making arguments and problem solving), Information and Technology Skills (information literacy, communication technology literacy, media literacy) and Life Skills (flexibility and adaptability, self-management, social skills, productivity and leadership) (Han, Kelley, & Knowles, 2021).

21st century skills and the qualities that an individual should have in solving daily life problems are listed. It is thought that STEM disciplines will be effective in gaining these skills throughout the world, including Turkey (Gülen, 2020). In addition to these disciplines, the individual can reach creative solutions in cooperation by using communication and information technologies and making use of all the opportunities at his disposal (Şahin, Ayar & Adıgüzel, 2014). They can easily create arguments and offer solutions on issues such as elections, environmental pollution, global warming, protection of natural resources, and renewable energy sources that concern all humanity (Marker, 2019; Honey, Pearson, & Schweingruber, 2014). It also emphasizes the importance of these skills due to reasons such as a qualified workforce and gender imbalance that prefer STEM disciplines. Another aims of STEM education is to increase the interest in these fields by enabling students to choose a profession from STEM disciplines in the future (Carnevale, Smith, & Melton, 2011). According to a study conducted by Istanbul Aydın University in 2014; While the occupancy rate of the quotas among the choices made in the fields of science-technology-engineering and mathematics in the 2000s was around 90%, this rate has decreased continuously over the years and has decreased to 38% in 2014. In fact, this rate decreased to 28% in 2010. In addition, while 72% of the preferences in these areas belong to boys, 28% of them belong to female students (Aydeniz et al., 2015). When similar studies and community needs are examined, three important target points for STEM education are determined: These points, which can be determined as economy, quality and choice or preference, have a significant impact on the development of the society and the individual (Aguilera, Lupiáñez, Vílchez-González, & Perales-Palacios, 2021; Gülen & Yaman, 2019).

Since the individual's STEM education from an early age may increase their preferences for STEM professions, the products, inventions or practical solutions made using STEM disciplines will benefit the economic development of the country. The professions preferred by the individual within the framework of STEM disciplines and the 21st century skills gained as a result of STEM education will affect both the elimination of the qualified job or worker shortage of the countries and the development. In addition, individuals who become literate with STEM education will significantly increase their follow-up or future studies for their own professions or business areas. It will be able to produce sustainable solutions from global problems to individual problems with decisions and choices for itself and the world (Gülen, 2016; Zouda, 2018).

STEM Integration

Today, the above-mentioned objectives of STEM education are tried to be implemented at the kindergarten, primary-middle-high school and university levels. Scientific studies are intensifying, especially for the solution of the problems experienced in the integration of STEM education into lower-level classrooms (Dönmez, 2020; Gülen & Yaman, 2019). In this integration, science-technology-engineering and mathematics disciplines should establish a harmonious and complementary context. It was emphasized that the realization of STEM education in schools depends on the integration of the model. Accordingly, integrations such as design-based STEM, Engineering-based STEM, 5E or 7E integrated STEM have been made. In addition to these, it is possible to come across STEM applications with argumentation integrated. In particular, STEM education applications with Toulmin argumentation model integrated are encountered (Ayaz, Gülen, & Gök, 2020; Gülen; 2016; Honey, Pearson, & Schweingruber, 2014;

Toulmin argumentation model integrated STEM education is based on the principle that STEM disciplines and Toulmin argumentation model support each other. The following model was developed based on Toulmin's (1958) model and STEM approach. In this model, students can collect data in a case they come across, create their claims based on these data, and design by determining the tools and materials for this claim. They can perform mental or physical operations on this design. In addition, it can determine the reasons, positive and negative aspects of its claims. At the last stage, they can transform their designs into products by using their tools (Gülen, 2016).

In figure 2 model;

Claim: Opinions or explanations for the solution of the problem.

Data: Events or observations used to support the claim.

Reason (Warrant): These are the reasons why the data support the claim.

Support: Examples are given daily.

Qualifier: Conditions that the claim is valid.

Rejective: Conditions that the claim is invalid.

Technology: It is the equipment used in the product to be built.

Engineering: Design of the product to be built and planning with existing technology.

Mathematics: Processes to solve the problem through the product.

Product: It is the concrete model that students use engineering and mathematics with

technology.

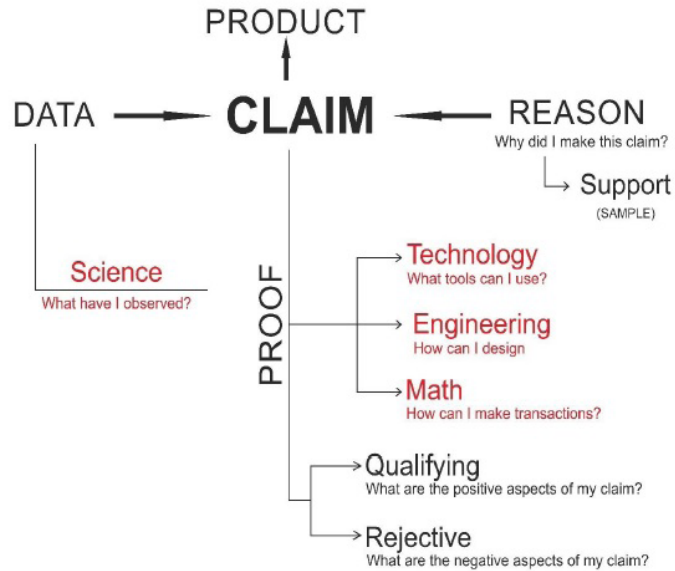*Science: Container concept covering every step described above* (Gülen & Yaman, 2019).

Figure 2. Toulmin Argumantation Integrated STEM Model

The model in the figure shows the use of the Toulmin argumentation model in the integration of the STEM education approach into the science course. In the activities carried out based on this model, the following student studies were obtained.

Example Activity 1

Teacher Salih teaches the planets on the subject of Solar System in Child Science and Technology course (participants are students studying Child Development associate degree program. Students are in the 19-20 age groups). Short documentary films prepared beforehand on the subject were watched. The preparation, editing and montage of these documentary films in accordance with the concepts were made by him. Students watched the movies in the links below.

http://www.biyolojiegitim.yyu.edu.tr/kf/sggezegennk/sggezegennk.mp4

http://www.biyolojiegitim.yyu.edu.tr/kf/sggezegennte/sggezegennte.mp4

After watching the documentary films, the students were given a data collection tool (Appendix 1). Accordingly, the students filled out the data collection tool. Data collection tool; It consists of My Data, My Claim and sections (Only one participant's data is presented below).

My Data

Question1: What did I observe in the video about planets? (Science)

K1. Planets are made up of dust and particles formed around them while Stars are forming.

My Claim

Claim: (I can form the claim based on the data above.)...

K1. The wobble of sunlight allows us to discover Planets orbiting them that are even smaller than Earth.

Question 2. What tools do I use for my claim? (Technology)

K1. Video but I can do it using a telescope

Question 3. How do I design for my claim? (Engineering)

K1. I make a telescope, a telescope capable of deep examination, and I observe the sun for a long time.

Question 4. What action do I take for my claim? (Math)

K1. When I observe the Sun, I think it's a planet blocking its light when a wobble occurs in the Sun's light. I can also calculate the distance of this planet from us by the wobble time of the light.

Warrant: (Why did I make this claim)…

K1: As the planet revolves around the Star, due to gravity, it attracts the star and causes the Star to wobble back and forth. This shows us the Planet.

Support: (I can give an example)…

K1. How long a star is extinguished and how much light is blocked tells scientists the size of the Planet and its distance from the Sun.

Qualifier: (What are the positive aspects of my claim?)…

K1. Thanks to these claims and methods, they think that they will be able to find a habitable Planet in the coming years.

Rejecter: (What are the negative aspects of my claim?)…

K1. Because scientists look through a telescope, they cannot detect Planets. They have to follow the stars to find out if a Planet exists.

As it is understood from the event, after viewing the participant videos and data; it is understood that s/he got information about the formation of planets and got an idea about planet detection. Based on these data, the participant claims that s/he can "discover planets as a result of the wobble of the Sun-Star light". The participant stated that by using a telescope (Technology) or by designing (Design-Engineering) if there is no telescope, they can operate based on the wobbling time of the starlight (Mathematics) so that they can discover planets. As the reason for this claim, the participant stated that there may be wobbles in the light due to the gravitational attraction between the star and the planet. The participant gave an example of calculating the yaw time in the light to support his reasoning. S/He also stated that s/he could obtain information about the size and distance of the planet based on this period. The participant stated that a habitable planet could be discovered in the future as the positive aspect of his/her claim, and that, as the negative aspect, the stars should be constantly followed-observed for planet detection.

Example Activity 2:

Teacher Salih studies NASA data on the ozone layer with his doctoral student. It supports this data with relevant videos on NASA's official website and channels such as YouTube. Below are the links used by the doctoral student to obtain data.

https://ozonewatch.gsfc.nasa.gov/monthly/monthly_2021-04_SH.html

https://www.youtube.com/watch?v=aU6pxSNDPhs

https://youtu.be/BL1ZsAlJKXU

After obtaining the relevant data, a data collection tool was given to the doctoral student. Accordingly, the students filled out the data collection tool.

My Data

Question1: What did I observe in NASA data and Ozone video? (Science)

It is seen that thinning increases in the South Pole between August and November. This causes the ozone density to drop below 220 Dobson and is called a hole. Also, very low temperatures in this region cause -70-80°C ice clouds. Cold is not the only reason for this reason. Population and solar flares also play a role.

My Claim

Claim: (I can form the claim based on the data above.).

Ozone depletion occurs due to the formation of ice clouds.

Question 2. What tools do I use for my claim? (Technology)

Computer, NASA data, polar observable if needed, thermometer, barometer

Question 3. How do I design for my claim? (Engineering)

If I measure the thermometer for air temperature, a barometer for air pressure and the density of icy gas, I can trade.

Question 4. What action do I take for my claim? (Math)

When the temperature values increase, I also examine the cloud density, these increases will show ozone depletion.

Warrant: (Why did I make this claim)…

Although the lowest temperatures start in August, this rate increases especially as September and October.

Support: (I can give an example)…

NASA data showed that thinning increased between August and November.

Qualifier: (What are the positive aspects of my claim?)…

When the average ozone density in the atmosphere is around 200 Dobson, ozone depletion occurs.

Rejecter: (What are the negative aspects of my claim?)…

Ozone depletion is not only affected by cold weather conditions, but also by increasing population and solar flares.

As understood from the event, the doctoral student learned about ozone depletion from NASA data and related videos. Based on these data, the participant claims that "Ozone depletion occurs due to the formation of ice clouds". The participant stated that by using a thermometer, a barometer (Technology), placing it in appropriate places on the pole (Design-Engineering), and using the relationships between the data obtained from these tools (Mathematics), s/he could determine the ozone depletion situation. As the reason for this claim, the participant cited the weather in the South Pole, which started especially in August and became quite cold like September. To support the participant's reasoning, s/he gave the example of the greatest thinning in NASA data between August and November. As the positive aspect of the participant's claim, s/he stated that ozone depletion occurs when the average ozone density in the atmosphere is around 200 Dobson. As the negative aspect of the claim, s/he stated that not only the cold weather conditions but also the increasing population and solar flares had an effect on ozone depletion.

As it is understood from the activities, the participants used the Toulmin Argumentation model and the integration of STEM disciplines (Before the activities, the participants were informed about the Toulmin argumentation model, STEM education and the integration of these two). Thanks to this, claims and all aspects of subjects such as the discovery of planets or ozone depletion have been determined.

Conclusion and Recommendations

Although the Toulmin argumentation model is for the philosophy of argument, it is understood that it can also be used in educational and scientific studies. Toulmin developed a model based on daily life conversations. In fact, today's educational goals are about solving daily life problems. Therefore, the philosophy of the Toulmin model and the educational goals overlap. As it can be used in all areas of society, it is also used in science courses. The basis of this model is to present all aspects of the claim about the subject or problem. This situation seems to be very useful in the science course. As a matter of fact, there are many different subject areas such as abstract, inaccessible (space concepts), dangerous (chemicals) in science courses. In order to understand these issues by students or society, in-depth knowledge is required.

Although STEM education has made a very rapid debut, in fact, the right goals are being imposed at the social level. The use of STEM disciplines is seen as the proportion of STEM occupations, the satisfaction of needs in terms of social welfare and economic power. Almost every subject of science course is related to STEM disciplines. Physics, chemistry, technology, mathematics and even biology are almost all related to STEM disciplines. It would be appropriate to use the principles of STEM education approach in teaching these subjects. Accordingly, many instructors have been using STEM activities in science classes in recent years.

The student is expected to be successful in solving daily life problems, which is one of the main objectives of the science course. One of the aims of STEM education is to enable the individual to use STEM disciplines in solving daily life problems. Similarly, casual conversations are one of the reasons for the development of the Toulmin model. These common goals can be combined into one integration point. Therefore, the Toulmin argumentation model with integrated STEM disciplines can be used to teach science course subjects. The model can be used as in the planets and ozone events given above.

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Appendix 1. Data Collection Tool

My Data

Question1: What did I observe in …………………..? (Science)

…………………..

My Claim

Claim: (I can form the claim based on the data above.).

…………………..

Question 2. What tools do I use for my claim? (Technology)

…………………..

Question 3. How do I design for my claim? (Engineering)

…………………..

Question 4. What action do I take for my claim? (Math)

…………………..

Warrant: (Why did I make this claim)…

…………………..

Support: (I can give an example)…

…………………..

Qualifier: (What are the positive aspects of my claim?)…

…………………..

Rejecter: (What are the negative aspects of my claim?)…

…………………..

Product; (Optional)

…………………..

About Authors

Salih Gulen completed his high school education in Iğdır, his undergraduate and graduate education in Van-YYU University, and his doctorate in Ondokuz Mayıs University Science Education. The author has worked in the fields of visual and virtual course material preparation, concept education, STEM education, Argumentation, Dependency, Technology integration. The author received his associate professorship in Science Education in 2021. He also taught in provinces such as Van, Tekirdağ, Samsun and Muğla. He is currently working at Muş Alparslan University Malazgirt Vocational School in Child Care and Youth Services department. Email: sgnova@windowslive.com https://orcid.org/0000-0001-5092-0495

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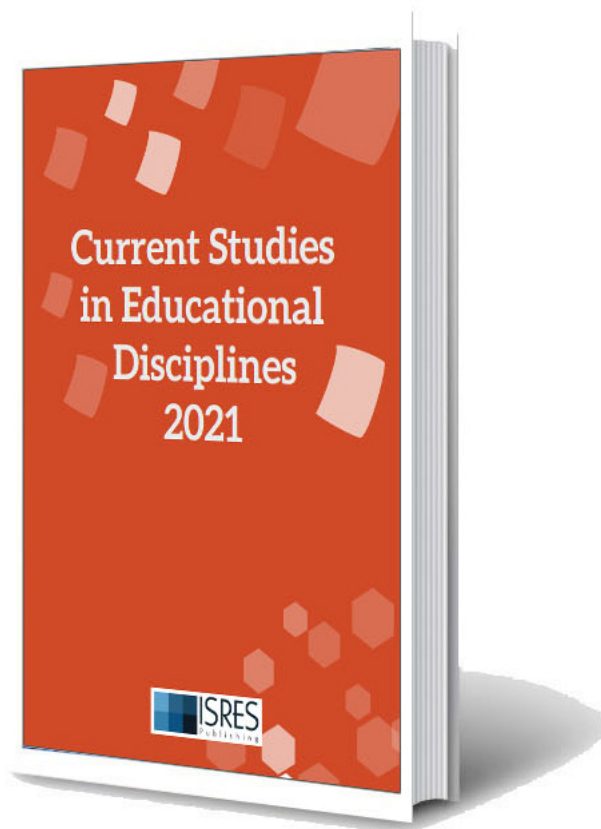
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