Scientific Paradigm Shifts and Curriculum: Experiences in the Transition to Social Constructivist Education in Turkey and Singapore

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Science-knowledge paradigms are epistemological frameworks that have emerged over long periods of time, changed and transformed sometimes slowly sometimes suddenly, and present models of knowledge, understanding, and interpretation at a specific period of time. Science-knowledge paradigms penetrated into curricula through textbooks in the "normal science" stage as conceptualized by Thomas Kuhn (1962). Therefore, a science-knowledge paradigm shift in turn changes the curriculum. While Newton (Bechler, 1991; Newton, 1999), the pioneer of the modern scientific paradigm, understood physics based on the notion of absolute time and space, Einstein (1960), the pioneer of the postmodern scientific paradigm, understood physics by placing time and space on relativistic foundations that were strengthened by Heisenberg's uncertainty principle. In time, changes in scientific paradigms have reflected upon the curriculum through a constructivist approach. The

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problem is how to explain and define the relationship between science-knowledge paradigms and curriculum. Many countries have started to adopt constructivist education since the late 1980s/early 1990s.In terms of shaping the educational approach and affecting curriculum, constructivism has started to become a dominant paradigm in different countries around the world. Thus, countries such as the USA, England, Germany, Spain, Canada, Australia, New Zealand, Finland, Israel, Taiwan, and Singapore have based their education reforms on constructivism (Bukova & Alkan, 2005). In addition to becoming student-centered, replacing collectivism with individualism lies beneath the educational approach in these countries. Student centeredness has been articulated as increasing student performance in Japanese education reform, as improving student's overall abilities and skills in full in Australian education reform, and as providing learner-centered education suitable for students' abilities and skills in Danish reform. Based on these examples, constructivism and student-centeredness can be concluded to be the bases in these countries' education reforms.

Constructivism, which has become the dominant approach in the world since the 1980s in teaching natural sciences in particular, has become an accepted approach by Turkey's Ministry of National Education (MoNE) with regards to program development after 2004. Likewise, MoNE has declared the adoption of the constructivist approach after 2004 regarding learning styles and theory of multiple intelligences in programs developed for the primary and secondary levels. MoNE officials stated a change toward a non-positivistic, probabilistic, and multicausational thinking style as opposed to a positivistic, deterministic, and linear thinking style. The only possible approach that allows for such a chance is argued to be epistemological constructivism with its subjectivist, relativist, and anti-realist manner (Ünder, 2010, pp. 199–200). The MoNE officials from 2006 interpreted the shift toward a constructivist approach in developing the curriculum as a transition to new thinking and a paradigm shift from the positivist paradigm, which they regarded as the sole perpetrator of all the negativity in the Turkish Education System. The essence of change was toward fuzzy logic, from positivism and the Newtonian, deterministic, linear, Aristotelian logic that was being left behind toward chaos theory as uttered by those dissatisfied with positivism, such as the postmodernists, feminists, and constructivists. It was a shift from analytical and behaviorist thinking toward a holistic, constructivist, cognitive style of thought based on quantum principles and multiple

causalities/probabilities. New constructs and concepts also occurred in the documents related to the developed curricula. MoNE has expressed constructivism to have been adopted during the curriculum development in its schedules and documents explaining the curricula (Ünder, 2010, p. 201). The president of the Turkish Board of Education (BED, 2005) stated that the need for rearranging education programs had emerged in order to create sustainable development and competitive power (pp. 8–9). In addition, they underlined the need for a contemporary system based on knowledge production rather than memorization in order to keep track of the constantly changing world, to reach and use the produced knowledge and accumulation, and to gain production skills (p. 6).

This study explores the curriculum changes after 2000 in the context of the abovementioned problem through the cases of Turkey and Singapore. These countries are of interest due to their experience in transitioning to constructivist education after 2000 and still constructing education through this experience. Our study looks for the answers to general questions that get more specific such as: What do science-knowledge paradigms mean? Through which processes are science-knowledge paradigms constructed? How have these paradigms been reflected on the curriculum? Can the traces of paradigm shifts be seen in the curriculum? In brief, what was the education curriculum like in Turkey and Singapore before 2000? Were there any curriculum changes in Turkey or Singapore after 2000? If any apparent changes occurred in the curriculum, how can they be explained in terms of the science-knowledge paradigm shifts? Our study in which we ascertain Singapore and Turkey after 2000 to have adopted the contextual and subjectivist paradigm, which changes based upon idiosyncratic situations, as opposed to the objectivist science-knowledge paradigm based on the positivist paradigm, attempts to depict how this shift has been reflected onto their curricula. The study attempts to present the constructivist curriculum understanding that guides both countries' curricula as well as learning theories and the scientific paradigms based on the re-constructivist approaches.

Our study will focus on the relationship between these two countries' curricula and the scientific paradigm shifts. We specifically need to mention that our study will be conducted in alignment with comparative education research. A discipline that allows an understanding of the similarities and differences among two or more education systems, explains the similar points, and proposes helpful suggestions with regards to educating people should be able to be understood by being aligned

with comparative education research (Türkoğlu, 1985). Comparative studies allow a flexible perspective through a multidisciplinary approach. Qualitative research has been observed to be used more frequently in comparative studies compared to quantitative research. We will also conduct a qualitative study. Qualitative studies are the most frequently used research method for international comparisons (Demirel, 1992; Lawerys et al., 1979; Türkoğlu, 2020). Comparing a researcher's own country to other countries is also a very common method. Comparative education compares the educational approaches, education expenses, school building characteristics, average education periods, education–state relations, student numbers, and many other similar points between two or more countries (Türkoğlu, 2020, pp. 9–10). Despite benefiting from previous comparative education studies, we have had to limit the study to how constructivism has been reflected on the curricula and its results because the main question in our study is to elucidate the relationship between the parameters of scientific paradigm changes and curriculum after 2000, specifically with regards to the main parameters of the countries being compared. Although specifically investigating textbooks as the embodiment of a curriculum is necessary and important, we have had to leave this topic to future specific studies due to the concerns of exceeding the boundaries of our study.

Science Paradigms and Curriculum

Thomas Kuhn's (1962) notion of paradigm consists of the methods and methodologies that are accepted by the members of a certain scientific community. Paradigm is a theory that determines the scientist's gaze on the outside world, regulates laws, and measures the research activities in the field of science the scientist directs (Kuhn, 1962). The traces of paradigm shifts can be seen in curricula. When scientific developments happen fast and life is everchanging, a static human nature is objected to. In such times, the educational approach presents itself as constructivism. The most important thought that defines constructivism as an educational theory is that problem-solving lies at the foundation of learning, thinking, and thus development as a result. Accordingly, people construct their understanding and comprehension through problem-solving and reflecting on their experiences or actions. As a result, learning needs to be an active process in which the learner inevitably changes.

At least two paradigm shifts have occurred throughout human history. The first happened when hunter and gatherer communities transitioned into police states and feudal societies with agricultural support systems, and the second occurred when tribal and feudal communities transitioned into capitalist, industry-based economies based upon scientific technology, consumption of unlimited resources, social advancement, unlimited economic growth, and rational thinking (Hall, 1954; Slattery, 2006, p. 19). For instance, the printing press changed the nature of intellectual communities, their information exchange, and their attitudes toward authority and what they deemed natural. The arrival of new tools (e.g., telescope, microscope, barometer, prism) and new theories (Galileo's law of free fall, Kepler's laws of planetary precession, Newton's theory of light and color) allowed the new science to gain a novel identity through a new language regarding phenomena, theories, hypotheses, and laws (Jacob, 1988). As such, these five fundamental changes created the modern science by interacting and intertwining (Abd El Khalick et al., 1998; Woottan, 2015, p. 630). Accordingly, the historical transition from industrial society (capitalist social structure) to information society (informationalism) has also brought along important changes in the field of education (Bell, 1973). In that sense, the course of industrialism since the eighteenth century has brought forth new information theories and application-based information. An understanding of a mechanical universe functioning like a mechanical watch persisted until the nineteenth century (Butterfield, 1951; Eddington, 1959). Besides its mental function, the practical, occupational, and economic function of education also became prominent. As a result, education programs (Lakatos, 1970) and applications that consider the economic and technological changes in the social structure of the West were introduced. The foundations of today's Western science has been laid through a series of scientific, technological, economic, and political changes across the seventeenth, eighteenth, and nineteenth centuries.

At the beginning of the twentieth century, two important revolutions paved the way for questioning and critiquing thoughts on modern nature based on deterministic-mechanistic premises. Albert Einstein's theory of relativity alongside quantum theory (Bohm, 1989; Ommes, 1994, 1999), which was established and developed by a group of physicist-philosophers such as M. Planck (1996), N. Bohr, W. Heisenberg, (1949, 1958), E. Schrödinger, de Broglie, P. Dirac, and W. Pauli, revealed modern natural thinking's insufficiencies based on deterministic-mechanistic premises at

great distances, high speeds, and subatomic levels (Arslan, 2011, p. 14). Naturally, education curricula were affected by this. If we are to understand curriculum as an interdisciplinary examination of the experience of education as William Pinar does (2011, p. 2), we must accept that curricula possess a unique past, complex present, and ambiguous future. Curriculum development won't have any paradigm shifts as long as the paradigm is in congruence with reality. For instance, from the moment Einstein proposed his theory of relativity for the first time to our day, no foundational changes have occurred as no concrete evidence has been presented to refute it (Cohen, 1994; Maftoon & Shakouri, 2013, p. 303).

Scientific change has been advocated to be very slow, and human nature doesn't change from culture to culture, era to era, or society to society when life is static. The educational understanding of such eras presents themselves as perennialism and essentialism. After 2000, a transition to a constructivist educational approach appeared in place of the educational philosophies that had been constructed based on classical scientific paradigms. New science paradigms started to affect curricula in the 1960s and have accelerated since 2000. Progress in science and an increase in information have been observed in mathematics, medicinal sciences, and technology more than the social sciences. One of the most important factors in this leap of progress is that research has become a new component of social and intellectual practices. This situation has also had the same effect on education and its development (Abd-El Khalick-Lederman, 2000). This is because school curricula have come to consist of the newest and most reliable information regarding all subjects. Paradigm shifts in the scientific field can be asserted as having an important role in the field of curriculum development without denying the impact of political, cultural, and societal effects. As such, the reality one sees will change based on one's perspective and the point where one stands in terms of perceiving and making sense of reality (Kocabaş, 2001). Newton, Galileo, Kepler, and Einstein looked at the same sky and reality yet had different things to say because their paradigms were different. The repercussions of understanding reality differently have a natural effect on a curriculum over time. As far as we can confirm in terms of curriculum development however, no specific study existing that directly links the scientific foundations of curriculum development to these types of situations, scientific paradigm shifts or curriculum is a grave shortcoming, even if they do mention theoretical, societal, cultural, psychological, or ideological foundations.

The Effects of Scientific Paradigm Shifts on Learning

The early effects of changes in information, science, and paradigms can be seen in learning theories (Moses-Knutsen, 2012). Thus, we in a way witness the paradigm shifts today by accepting various perspectives and experiencing deep conceptual transformations in our thinking structure due to scientific, technological, social, or cultural developments. When we experience a paradigm shift, our thought structures acquire conceptual systems and new ways of thinking unlike the ones before; perhaps we start to think about topics that we had perceived and explained in the same manner for years from a fresh perspective (Shapin, 1996). In that sense, the transitions from a geocentric to heliocentric universe, from phlogiston theory to oxygen-burning theory, and from Newtonian physics to quantum physics (Köseoğlu & Tümay, 2013, p. 1; Peacock, 2008) can be examples of paradigm shifts in science. The twentieth century has also had important changes with regard to paradigms about the nature of learning. Due to the evidentiary questioning and discussions on the pros and cons of the alternative theories that have been proposed in regard to the nature of learning in the past century, an important paradigm shift toward cognitivism and constructivist learning theory has occurred after 2000 in particular with regard to how learning is thought to occur (Cooper, 1993, pp. 12–19; Köseoğlu & Tümay, 2013, p. 2). This paradigm shift has altered perspectives on education; as a result, philosophy of education and teaching methods have been greatly reconceptualized (Köseoğlu & Tümay, 2013, p. 2).

As a result of these shifts and in order to enhance education, the question of how can we teach better was left behind for the question of how do people learn, especially in the 1960s. Accordingly, cognitive psychology, started to flourish and would rock the foundations of educational traditions. The mind is no longer understood as a black box as conceptualized in the behaviorist approach; learning cannot be understood based only on stimulus–response behavior, and learning is a process with cognitive and emotional components. According to cognitive learning theory, the individual in the learning process creates cognitive models, and these models change through new experiences (Köseoğlu & Tümay, 2013, p. 2; Phillips, 1995, pp. 5–12). The constructivist approach, which is based on cognitive learning theory which has become became prevalent since 2000, prefers a cognitive structuring

based on the process rather than based on product. Constructivism has dramatically affected all aspects of education around the world these days and become the pioneering paradigm in education (Jonassen, 1991).

In the 2000s, the reconceptualist movement also brought a paradigm shift in the field of education scheduling alongside constructivism, underlining the need for experts to focus on understanding the existing syllabus and the field in place of the syllabus development approach that had been the focal point of the field until the 1970s (Korkmaz, 2016, p. 39). According to Cooper (1993, pp. 12–19), an important paradigm shift toward cognitivism and constructivist learning theory happened, especially since 2000, with regard to how learning is thought to occur due to the evidentiary questioning and discussing of the pros and cons of the alternative theories that had been proposed regarding the nature of learning over the past century (Köseoğlu & Tümay, 2013, p. 3). The most important effects of such a paradigm shift have been students being placed at the center and ejection of empty information from the curriculum, with learning to learn being brought to the fore.

The Parameters of Curriculum Change in Turkey Since 2000

More than one effect has been influential on Turkey's curriculum formation. Just as scientific paradigm shifts influence curricula, so to do political and societal factors. When evaluating the Republican Period education system in terms of the philosophy of education, the effects from various educational movements appear such as perennialism, fundamentalism, progressivism, and re-constructionism; all are found in the fundamental aims of national education (Güler, 2020, p. 212). The Republican Period philosophy of education had not been influenced by any one philosophical movement but had been shaped by the philosophical movements and thoughts in the world at the time (Güler, 2020, p. 212). Constructing a unique philosophy of education in Turkey has had its risks due to the political mechanism being in charge of education and the country being governed by a bureaucratic administrative mentality. The reason no unique philosophy of education occurred since the Republican period is that education has been under political control and the developments resultingly cannot be monitored as desired: no unique, societal, transcendental aim exists (Güler, 2020, p. 213).

In that sense, individuals would have usually been evaluated based on their quantitative and verbal abilities and thought in line with the education paradigm adopted in Turkey before 2000. However, in line with the new intelligence paradigm that started being adopted after 2000, having individual evaluations of quantitative and verbal abilities, which are only two of eight potential dimensions, in line with the education paradigm that had been adopted in Turkey would mean neglecting the other dimensions. This can be considered as a waste of the wealth of individuals' potentials (Erdoğan, 2004, p. 61). Therefore, education and teaching efforts have allowed students to develop their potentials multi-dimensionally. Education and teaching are structured based on students learning styles, interests and abilities, and thoughts and emotions. Textbooks have been designed based on the theory of multiple intelligences (Öztürk, 2011). The teacher doesn't need to stick with only one method as topics now have several activities. In this way, students with different intelligence structures are given a chance at being successful, with students having started to use the learning method that is easiest for them with regard to topics they have trouble learning.

The developments occurring in the world regarding learning and teaching methods greatly enhance individuals' learning possibilities while giving individuals an active role rather than a passive one. When the learner-centered approach became prevalent worldwide at the turn of the millennium, Turkey also transitioned to the constructivist method, which has since 2005–2006 allowed itself to be effectively and efficiently used for redesigning primary and secondary curricula (Kenan, 2013, p. 26).

As a natural consequence of such developments, certain changes have also occurred since 2000 on how knowledge is conceptualized, which is the main topic of education. The notion that knowledge is emphasized to not be dogmatic, yet this is still debated even though its validity has been proven through the scientific method. Knowledge according to constructivist theory is associated with the beliefs and values of the society in which it is produced. The need to reproduce knowledge through science-based interactions has been underlined rather than the pure transference of science. Not future functionality of science but its present functionality should be given attention; accordingly, knowledge should be regarded as a temporary accumulation that makes sense in relation to the individual and society. Individuals shape knowledge in their own way as opposed to just memorizing it as it is. In other words, individuals are actively involved

in their knowledge production. Therefore, education is based on reproducing knowledge, not transferring pure knowledge. Individuals reason out everything around them and everything they confronted, reflecting on these things thoroughly, trying to understand who they are, and connecting with life after merging and comparing with previous knowledge. Therefore, thinking correctly and showing the correct use of the mind and knowledge should be the basis instead of learning more things and transferring knowledge. This should be given attention in education and teaching. Education systems should pave the way for students' thinking and use of reason.

The document On Our Activities Regarding Curriculum Renewal and Change, issued by Turkey's Ministry of National Education (MoNE, 2017), states that, starting with the fall 2016 semester to the present, a comprehensive renewal activity has been occurring on 51 curriculum levels indicating transformation. The current curriculum has been renewed in line with the necessities of the era in the context of innovations and developments in teaching-learning theories and approaches as well as the changing needs of individuals and society. The changes made regarding this renewal are explained in response to the questions of why the curriculum was renewed, how has the curriculum been renewed, what has been done in the renewed curriculum, what are the prominent innovations in the curriculum, and how will curriculum activities continue (MoNE, 2017). How the curriculum is renewed is answered by stating that various countries' curriculums that were renewed for similar reasons have been investigated, new studies in the field of education have been scanned worldwide, teachers' and administrations' opinions regarding the curriculum and weekly schedules had been collected through officially conducted surveys, and data from an online survey consisting of subject-specific open-ended questions have also been gathered (MoNE, 2017). When examining the answers on how the curriculum has been renewed, the process can be concluded to have been conducted in accordance with the process of the scientific paradigm shift.

The question of what has been done in the renewed curriculum is answered in the context of values with justice, friendship, honesty, self-control, patience, respect, love, responsibility, patriotism, and altruism having been determined as the root values the curriculum aims to transfer to students. In addition, society's expectations from its future members have changed with regard to the scientific, technological, and

societal changes and developments that have occurred alongside societies' transition from the technology era to the information era. Such developments and advancements entail that students acquire cognitive competencies/abilities such as critical thinking, original thinking, research, problem-solving; social competencies/abilities such as societal and cultural participation, entrepreneurship, communication, and empathy; and personal competencies/abilities such as self-control, confidence, commitment, and leadership in addition to acquiring foundational knowledge and abilities (MoNE, 2017).

When looking at answers to the question of what have been the prominent innovations in the curriculum, placing emphasis on the simplicity and comprehensibility of the new curriculum draws attention, as well as the examination of most countries' (Canada, Australia, India, New Zealand, America, Uganda, Thailand, England, Malesia) curricula and written materials as prepared by the European Union and UNESCO, in addition to academic articles regarding education. In addition, the reason why these values are in the curriculum has been stated, as well as how they took place, how they can be transferred to students in the teaching–learning process, and explanations regarding which teaching methods and techniques should be used while conveying values. Most importantly, the effort was made to take the diversity in cultural and civilizational reservoirs into consideration while renewing the curriculum in order to have balanced exemplifications. The acquisitions and explanations regarding scientists and thinkers from various backgrounds are expressed by introducing their works as having resulted in the emergence and development of science and scientific thinking, this to have occurred through the contributions of such individuals, and science and scientific thinking to have universal value (MoNE, 2017). The section stating the knowledge, abilities, and attitudes regarding the competencies and skills students are aimed to acquire in the renewed curriculum particularly emphasizes subjects such as information and technology competency, digital competency, and learning to learn (MoNE, 2017).

Some cautionary expressions can be seen regarding subjects such as information and technology competency and digital competency in MoNE's paper titled Turkey's Education Vision 2023. As such, comments in the text such as the balance between humanity and technology are spread out in favor of mechanization; scenarios once considered to be science fiction have become ordinary, alive, and current representations of today. The singularity period aims to merge the biological, digital,

and physical into one mold (MoNE, 2018). Evaluating these cautionary comments along with transhumanism and posthumanism as the recent Western debate topics and in a sense as the culmination of a series of developments since the seventeenth century gives clues about the future of the emphasis on the singularity in the new curriculum (Dağ, 2019).

While the theoretical importance and meaning of MoNE's efforts regarding the new curriculum is still under debate, most of the problems occur in their implementation because the new curriculum has been planned independent of the foundational components of education. In practice, other components such as teachers and learning-teaching environments hadn't been taken into consideration in terms of how ready and suitable they are for this practice. Even though the new curriculum, which aims to make students more active, is beneficial in terms of individually paying attention to students and presenting various learning options rather than one, in practice, the experience has shown teachers and school/class environments had to be adapted and teachers and schools to not have been readied enough in how to implement to achieve the desired outcomes (Gür & Çelik, 2009, p. 32).

With regards to the statements and practices MoNE made in 2004, 2006, 2017, and 2018, MoNE can be concluded as evolving incrementally toward an education in line with the new curriculum and in parallel with scientific developments. Even though MoNE had struggled between positivism and constructivism on an eclectic level, lacked meaningful integrity, and encountered some problems in practice, it is moving step-by-step toward a curriculum in alignment with the contemporary scientific paradigm. Analyzing the problems in practice and turning them into an experience rather than a misfortune is possible.

The Parameters of Curriculum Changes in Singapore Since 2000

Singapore's special importance among the other countries that have transitioned into constructivist education becomes immediately apparent. Even though Singapore seriously differs from Turkey in terms of population rates and structures, geographical location, and political structure, comparing Singapore to Turkey is thought to be meaningful due to Singapore's determined and consistent implementation of the scientific paradigm shifts into the curriculum and its successful results. The most important reason why we conduct such a comparison is to explain

how Singapore has accomplished more compared to Turkey on assessments such as and Program for International Student Assessment (PISA) despite experiencing similar reform activities. As such, while the Singapore education system showed mediocre performance in 1985, important accomplishments have been observed post-2000 with the help of education reforms (Bakioğlu & Göçmen, 2013). The role the notion of new education has had on Singapore's success needs to be explained, as well as what kinds of changes happened in the curriculum regarding its understandings of learning, student, and teaching.

Singapore's education system can be divided into three periods (Levent & Yazıcı, 2015, pp. 123–126; Ng, 2019, p. 45). The first period was based on salvation and was known as the standardization stage (1959–1978). The second period was the benefit-oriented period, also known as the stage of local accountability (1979–1996) The third stage is the skill-based development period, also known as the diversity and innovation stage (1997 to the present). We will mainly focus on the skill-based development period from 1997 to the present. In 1997, Singapore President Goh Chok Tong declared a new vision called Shaping Our Future: Thinking Schools, Learning Nation, and within the framework of this vision, he specifically ensured the development of critical and creative thinking in addition to process-based evaluations rather than outcome-focused ones. The Thinking Schools, Learning Nations Committee (TSLN Committee) was founded next by Singapore's Ministry of Education (MoE) in August 1997 in order to strategize for future education reforms. This committee prepared the report titled A Curriculum Investigation Suitable for Learning, Creativity and Communication (Levent & Yazıcı, 2015, p. 126). In 2000, the inspection system was removed, and a school self-evaluation system called the School Excellence Model was installed. In 2005, MoE transformed the concept regarding program and teaching administration and implementation and began conceptualizing the Teach Less, Learn More (TLLM-2005) initiative to ensure students' deeper learning (Ng, 2019, p. 59). This was because Singapore was understood to have only been successful by overloading content on small students and leading them to study, but these practices had in turn prevented the emergence of creativity in the students (Ng, 2019, p. 51).

The learning principles of the new vision and the characteristics of the curriculum have been presented as follows (Ng, 2019, pp. 139–140):

- Structuring as opposed to transferring knowledge
- Comprehending content rather than memorizing it
- Mindfully applying methods rather than mindless activities
- Social constructivism rather than individual study
- Self-guided tasks rather than teacher-guided tasks
- Structuring and self-evaluation rather than general evaluation
- Learning to learn rather than learning a subject.

These principles apparently suggest a serious change in the fundamental qualities of learning and teaching in the Singapore education system.

In 2003, the master plan of the new vision started to be integrated into the curriculum, and innovative schools started to become widespread. In 2004, special programs from 7th through 12th grade with greater learning opportunities began being implemented to some students. In the same year, a program allowing strengths to be brought forth rather than academic grades was offered to students. In 2005, the pedagogic change encouraging active and independent learning as underlined for developing questioning, critical thinking, and inquiry-based learning among students started to be implemented by reducing the curriculum. In 2006, students started to have the chance to choose learning and different levels of study among each subject as students worked on at least one subject different from their specialty (MoE, 2007). In 2009, in addition to previous applications, curricula and environments suitable for students' self-directed and collaboration-based learning, the emphasis on confident individuals, self-directed active students, and sensitive students as had been emphasized in 1997 was restated within this framework. In 2010, social-emotional competencies intended as the four results of education and the vision supported by the group of values were declared within the complete curriculum framework. In line with this, the Primary Education Review and Implementation (PERI) committee was founded in order to evaluate and enhance the quality of primary education in Singapore, including social-emotional development, non-academic curriculum, and life-long learning (MoE, 2009). A more effective strategy had been adopted over the topics of holistic evaluation, active learning programs, physical education, and arts and music education as one of the key initiatives.

In 2014, the Singapore MoE defined a framework for twenty-first-century skills and student outcomes. This framework is focused on a more holistic approach for students to develop preparedness qualifications

such as creativity, innovation, intercultural understanding, and resilience. In 2015, the education dissemination was transformed into SkillsFuture Singapore (SSG), a movement that represents life-long learning and encourages life-long skill development throughout adulthood (Ng, 2019, p. 52). Accordingly, the main purpose of schooling in 2015 was emphasized as creating a confident, self-learning, actively contributing, and sensitive citizen. The aim was for individuals to gain the series of twenty-first-century competencies that were deemed necessary for living and working in the globalizing world. This is in line with the current global discourse regarding curriculum policy, implementation, and evaluation that emphasizes the importance of helping students develop twenty-first-century competencies (Dede, 2010; Deng, 2013, p. 264; Voogt & Roblin, 2012). However, even though Singapore's aims with the new education paradigm are comprehensive, their success at reaching these aims can be said to be limited to examinations because the Singapore education system is still very centrist, examination-focused, competitive, and stressful for students. Singapore is still in the process of catching up with other developed countries regarding early childhood education and special education (Ng, 2019, p. 280).

According to 2012 PISA results, Singapore students are the best problem solvers. However, this result can be deceiving because Singapore students are famous for their over-practice on questions, even memorizing them. The Singapore education system is transitioning from the past paradigm to the new paradigm, a transition where two opposite discourses are present at the same time. Example practices are found that show the essence of the new paradigm, but the old paradigm still prevails. That's why Singapore separately possesses both problem-solving students and memorizing students. Singapore even has students who solve problems while memorize them. In order to completely understand the nuances of the change, emerging multiple realities in the apparently contradicting examples and stories sometimes needed to be adopted simultaneously. However, such contrasts are not the two ends of the process but two faces of the same coin. This produces the creative tension that is necessary for change. The incongruence between them may produce new ideas. Exploring the boundaries of Singapore's accomplishments is impossible without adopting different perspectives, comprehending different levels of realities, and accepting contrasts. In fact, such variety has helped Singapore turn into a better system (Ng, 2019, pp. 19–20).

Comparing the Paradigmatic Features of the Curricula Change in Turkey and Singapore after 2000

Turkey and Singapore possess quite similar aspects and features regarding how they've reshaped their curricula based on scientific paradigm shifts. In short, the education approach in Singapore is a student-centered and value-based education. They seriously try to implement this situation in their curriculum. Being student-centered is in alignment with the effects of scientific paradigm shifts and changes on learning. Values-based education, on the other hand, is at the center of the new curriculum understanding of Turkey. Despite the problems in implementation, Singapore and Turkey seem determined in being student-centered and value-based education.

However, both Turkey and Singapore struggle with theoretical problems in addition to practical ones. For instance, the Turkish education system adopted constructivism over positivism in 2006. However, according to Ünder (2010), such a comprehensive change is unfortunately absent in the prepared program. Although the traces of constructivism can be improved in terms of relativism and anti-realism, constructivism with a realist ontology and an understanding of empirical knowledge is mainly encountered in the program rather than a relativist and anti-realist constructivism. Additionally, Kuhn's understanding of science is only applied while explaining the changes in the scientific models and choosing between theories. The positivist and constructivist educational approaches were not put together by synthesizing them but in a makeshift eclectic manner. The repercussions of falsifiability, social factors, and instrumentalism have not been consistently accounted for. The benefits of radical constructivism with regards to raising non-scientific values have not been utilized in curriculum development. According to Ünder (2010), claiming the foundational philosophy of the program to be constructivist as the Ministry states is as a result impossible. Considering program changes as a paradigm shift is also impossible. If these teaching programs are considered constructivist, Glasersfeld's ordinary constructivism fits here perfectly (Ünder, 2010, p. 211). As an example of this contradiction, Ünder points to the constructs used in science and technology textbooks such as fact, truth, discovery, and representation (pp. 207–208). When examining the Turkish curriculum, the most problematic issue in terms of content is that it is additionally based on

information overload. Even though a transition since the 2005–2006 academic year has been going on toward a constructivist philosophical understanding that is student-centered and activity-oriented in which information is structured and the teacher is simply a guide, claiming that the goals have been reached is currently impossible. A comprehensive renewal (update, review, replenishment, and change) activity regarding the curriculum was done for this purpose in the 2016–2017 academic year.

The many studies regarding constructivism's integration to the Turkish curriculum as claimed by the Ministry of National Education resulted in opposite findings. In a study by Karadüz (2009), constructivism in the assessment and evaluation process was unrelated to claims. In another study by Yıldırım, teachers were found to experience problems in creating constructivist learning environments. Bayraktaroğlu (2011), however, underlined the problems with regard to implementing constructivism. Specifically, changing the national education program based on the results of other countries without conducting detailed studies that introduce the aim and features of the constructivist theory in Turkey, and more importantly, without allowing the practitioners to practice and present wide information regarding implementation methods and techniques, has only resulted in a simple content change. The inadequacy and lack of knowledge in implementation is also creating a chaos of sorts, let alone not increasing the effectiveness of education.

The number of activities per page in the textbooks of Singapore students is found to be five times more effective compared to the textbook representing Turkey that students use in terms of activity segments per page. In addition, the activities in the textbook representing Turkey are not suitable for the activity concept of realistic mathematics education. First of all, the aim of these activities is the use of thought information rather than strategizing or modeling for a problem situation that has roots in real life. In other words, the presentation of formal information is followed by its application. However, an activity that is designed in accordance with the realistic mathematical education, which is influenced by the constructivist educational approach, will have a problem situation with comprehensible beginning points and include real-life situations the students can envision and tackle. Students do the math and create a model over the problem situation. However, the activities in the

textbook representing Turkey serve the aim of applying the listed instructions by making use of some materials to filter all individuals through the same comprehension level (Gün & Atasoy, 2017, p. 82).

Despite the new curriculum understanding in Turkey, education practices and textbook have not enabled students to fully learn by themselves. Excessive class hours, barriers in developing personal skills, and underdeveloped ability to self-direct are important problems. However, the most important problem is probably the mentality problem regarding internalizing and justifying changes. As such, both existing teaching staff and student roles that are shaped based on social acknowledgements are barriers for now. The most important consequence of this barrier is the examination-centered education system. The most important cause of the inequalities in education is also the examination-centered competitive environment. However, the scientific paradigm shifts are singularly challenging not just for some countries, but for the educational approach and curriculum of the whole world, forcing all to change tomorrow, if not today.

Conclusion

In this research we conducted regarding knowledge-science paradigm shifts, we first explained the terms knowledge, science, and paradigm. Then, we elaborated on the relationship curriculum has with the knowledge-science paradigm shifts. We've seen knowledge-science paradigms historically to have eventually affected the education curriculum. In other words, we've seen developing a curriculum independent of scientific paradigm shifts to be impossible. Even though Turkey and Singapore are very removed from one another geographically as well as in terms of cultural, economic, and political features, they have both been affected by the new scientific paradigm that had emerged in the seventeenth century, developed in the eighteenth and nineteenth centuries, and became apparent in the practices of the twentieth century: They have aimed to implement this paradigm to their curricula through constructivism. Instead of an approach that is Cartesian, positivist, or purely information-based, the aim is for an approach that puts the individual at the center, where they learn to learn, restructure what is learned in the mind, have an understanding of truth and reality that changes over time and space; an individual who is pluralist and open to alternatives rather than truths that apply to life and are indisputable. The new theory

of curriculum that has begun being prevalent in Turkey and Singapore can be said to be superior in terms of its student-centeredness, pluralist structure, and openness to alternatives compared to the old curriculum based on the old paradigm. Being open to new technological innovations and actively using technology more in learning processes are also prominent features of the new curriculum. However, the new theory of curriculum waits for future comprehensive studies in terms of its relationship with transhumanism and posthumanism.

Now we can present some of our findings in bullet points:

(a) The post-2000 curriculum changes in Turkey have brought along problems such as creating an examination-focused and competition-based educational atmosphere due to discourses such as "Mapping out the life of an entrepreneur" and "designing a product in the best possible way and marketing the projects" (MoNE, 2004, p. 35). The most important consequence of this situation has been the deepening of inadequacy experienced in education. Even though the individual has been brought to the fore in the curriculum, statements such as "having students be sensitive toward societal issues" and "realizing the societal existence of the individual" (MoNE, 2004, p. 45) were only mentioned once in a while. In the curriculum, the aim is to highlight students' aspects such as critical and creative thinking, communication and empathy, research, problem-solving, decision making, using information technologies, and entrepreneurship.

(b) Even though constructivism in Turkey has allowed for positivism to be questioned, the changes in the MoNE 2005 and MoNE 2006 programs were neither fully necessary nor sufficient. MoNE's curriculum has adopted a realist ontology and empirical understanding of knowledge, even though constructivism possesses a relativist and anti-realist perspective. This is a consequence of the imported education approach that we pointed out in the previous section. This shows constructivism to have been unable to create a real paradigm change in the Turkish education system. The Singapore curriculum program seems more consistent in this sense. Singapore has a constructivism that has evolved over time as opposed to a relativist and anti-realist one with a positivist understanding. However, comparing Singapore's accomplishments

to Turkey's is also questionable as the consequence of Singapore's transition to constructivism has been limited only by their success on examinations. Singapore also has a smaller population compared to Turkey's. When taking these factors into consideration, comparing the successes and failures of both countries can be re-thought.

(c) Singapore and Turkey's education systems and their understanding of their curricula started to change almost at the same time, and they both have set out with similar questions in mind. The main concern of both countries is how to adapt to the globalizing education system in a changing world while educating students accordingly. Both countries want to design a curriculum in alignment with the scientific paradigm shifts, and neither want their students to lag behind the world.

(d) One of the commonalities between the two countries is also the parallels between their political independence process and transition into a new educational approach. At the beginning of the foundation of the republic, Turkey has also started to search for a new paradigm regarding education; after trying out some education approaches, they have started to implement the constructivist paradigm in the education system since 2000. Singapore also started to search for a new paradigm in education after their independence from England in 1959 and separation from Malaysia in 1965.

(e) The Singapore education system and understanding of curriculum have essentially been developed as a response to globalization. Even though many problems have occurred in its implementation, Singapore's success in TIMSS and PISA are striking (OECD, 2010). This should serve to remind that no success is without its problems. To be successful is not to have an issue-free education and curriculum. Singapore is an interesting example in terms of finding success in the face of implementation problems. In terms of the curriculum, Singapore's approaches developed regarding education and the methods followed in problem-solving provide a rich experience and serious knowledge accumulation. In addition, we hope that Singapore's accomplishments and struggles will be of interest to curriculum developers, researchers on curriculum, and other practitioners in the system.

Suggestions

1. The question of why Turkey and Singapore have ended up with different results despite using similar methods awaits extensive examination. We are of the opinion that both structural and varying factors will become apparent once such comprehensive studies are conducted.
2. The textbooks in Singapore and Turkey can be investigated by year, and their changes can be compared in terms of the effects scientific paradigm shifts have on the curriculum. Doing so allows examination of which country has achieved its intended results and how.
3. How close Singapore and Turkey are to predicting the future as much as catching up on the present as well as what the relationship is among the new education trends, transhumanism, and posthumanism can be explored through comprehensive research.
4. The literature in Turkey regarding the degree to which the curriculum has been affected by the changing and transforming paradigms is scarce. Specifically, the relationship between the new education approach after the 2000s and the scientific paradigms prevailing in the world should be researched extensively and in-depth.

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