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A Comprehensive Analysis of the Integration of ESD Competencies in a Primary Four Curriculum in Egypt: A Case Study

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A Comprehensive Analysis of the Integration of ESD Competencies in a Primary Four Curriculum in Egypt: A Case Study

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A Thesis Proposal Submitted in Partial Fulfillment of the

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Master of Arts in International and Comparative Education

By Aya AbdelHakim El Kholy

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Declaration of Authorship

I, Aya AbdelHakim Elkholy, declare that this thesis titled "A Comprehensive Analysis of the Integration of ESD Competencies in a Primary Four Curriculum in Egypt: A Case Study" and the work presented in it is my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. Except for such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: 

Date:

May 18, 2024

Table of Contents

Abstract

This qualitative study examines the integration of Education for Sustainable Development (ESD) competencies within the Primary Four Science Curriculum in Egypt under the Education Reform Project EDU 2.0. ESD competencies are viewed as essential for empowering citizens to address real-world challenges. Utilizing a qualitative research design, the study employs document and content analysis of the teacher guide of the Techbook to investigate the incorporation of these competencies. Additionally, interviews are conducted with science teachers to gain insights into the application of the curriculum design. Interviews with curriculum developers directly involved in the curriculum development process with the Egyptian Ministry of Education and Technical Education (MOETE) are also conducted. Furthermore, insights are gathered through an interview with Dr. Tarek Shawki, the former Minister of Education and Technical Education of Egypt, who initiated and led EDU 2.0. Dr. Shawki shares perspectives on the contextual factors, objectives, and philosophy underlying the curriculum design, as well as the challenges encountered in its implementation. This study contributes to the understanding of how ESD competencies are integrated into the curriculum and sheds light on the practical challenges and implications of integration, highlighting the pivotal role of teachers in the educational process.

Keywords: Education, Education for Sustainable Development, Science Education, Sustainable Development Goals, Content Analysis, Science Curriculum, and Education 2.0, Egypt Vision 2030.

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List of Figures

List of Tables

List of Abbreviations

AUC: American University in Cairo

CBET: Competency-Based Education and Technical Education

CCIMD: Center for Curriculum and Instructional Materials Development.

EE: Environmental Education

EKB: Egyptian Knowledge Bank

ESD: Education for Sustainable Development

Edu Camp: Education for Sustainable Development Beyond the Campus

GCED: Global Citizenship Education

HEI: Higher Education Institutions

K/S/V: Knowledge/ Skills/ Values

MDGs: Millenium Development Goals

MOETE: Ministry of Education and Technical Education

MOETE: Minister of Education and Technical Education

NOS: Nature of Science

PIRLS: Progress in International Reading Literacy Study

SDGs: Sustainable Development Goals

SE: Science Education

SSI: Socio-Scientific Issues

TIMSS: Trends in International Mathematics and Science Study

Chapter 1: Introduction

1.1 Background and Significance

Many challenges in the Egyptian education system have been present in the past decades due to overpopulation, overcrowded classrooms, poor teacher calibers, and lack of attention to professional development (UNICEF, 2018). Curricula remained outdated for a long time, and teaching was mainly focused on rote memorization rather than promoting higher-order skills (Rezk & Magd, 2022). Despite the large enrollment rates in basic education, the quality of learning is compromised (USAID, 2022). Egypt scored below the low benchmark on the Trends in International Mathematics and Science Study(TIMSS) in 2019 (TIMSS & PIRLS International Study Center at Boston College, n.d.). Graduates also face challenges when they start their careers, as they feel their education did not serve them well in preparing them with the needed skills for work life, in what is manifested as the "Skills Gap "(Roach, 2022). This challenge affects the employers' side as well. According to a report by Angel-Urdinola and Semlali (2010), graduates in Egypt voluntarily choose not to work in jobs outside their area of education, yet they find it difficult to find jobs matching their qualifications, which further exacerbates the unemployment problem. In a labor survey conducted by the International Labor Market (ILO) in Egypt, 30% of unemployed youth refused a job because they felt it "did not match their level of qualification." (Abdel Ghafar, 2016, p.6). This unemployment phenomenon highlights the education-occupation mismatch in which university graduates are not equipped with the skills and knowledge to prepare them for a career within their field of study." The Skills Gap", refers to the gap between education and market demands, which is another existing challenge globally (Cornelius, 2011). This challenge faces the Egyptian job market as well for the same reasons (Roach, 2022). To tackle these challenges, in 2017 the Ministry of Education and Technical Education (MOETE) launched Education 2.0 (EDU2.0) reform to shift teaching from rote memorization to Critical Thinking (USAID, 2022). The introduction of a new curriculum with a new philosophy after many years of stagnation of the preceding ones has led to unrest among Egyptian parents, students, and some educators.

As a science teacher myself for 10 years, teaching different curricula in the Egyptian national system, British and American systems, I was impressed by how this new curriculum was similar to the international curricula of science. After these years of science teaching, I thought that it was revolutionary, compared to its predecessor curriculum. However, my science teacher colleagues were challenged by the application of these new concepts and pedagogies, especially during the Pandemic unsettlement during the Academic year of 2021/2022. Even though educational technology has been significantly developed in recent decades and has been proven to be highly valuable during the pandemic (Dhawan, 2020), educators, including teachers, students, parents, and other stakeholders, encountered plenty of unexpected and unprecedented challenges (Chakraborty et al., 2020). Educators around the world have reported this time to be one of the most challenging in their variable years of teaching experiences (Huck & Zhang, 2021). Being a Science teacher, I found it very intriguing to delve deeper into investigating the controversy over this new curriculum under the reforms of EDU 2.0 from a research perspective, relating to the literature on good quality education and its theoretical underpinnings.

A comprehensive analysis of the Primary 4 Science curriculum is done in this study, as a way to delve deeper into these new reforms. In Chapter 2, the literature review begins with presenting findings from the literature that answer questions related to the overarching purpose of learning from the different perspectives of ancient and contemporary education philosophers, such as Dewey (1956;1974), Aristotle, Plato, and others, through the critical reviews of the studies by Hannon (2015), Watson (2016), and Darder et al. (2023). It is claimed that there is consensus that the ultimate purpose of learning is to help students tackle real-world problems. Good quality education is one that helps students think about the connections between individual problems and experiences within a social context (Sporre & Mannberg, 2010). These problems in the context of this study are referenced within the Sustainable Development Goals (SDGs) ([United Nations], UN, 2015).

In the light of the United Nations (UN) Agenda 2030, global challenges have been situated in the 17 SDGs. These goals address the challenges in three dimensions; the Environmental, the Economic, and the Sociocultural. Egypt has its own agenda for development to achieve the 2030 Agenda for the SDGs. Egypt, as one of the 193 countries that were members of the UN Agenda for SDGs 2030, developed its own vision which is "Egypt Vision 2030", entailing the strategic plan of the country over the course from 2016 to 2030 in the different aspects of development. The vision as quoted on the website of the Egyptian presidency is described as

"By 2030, Egypt will witness a comprehensive renaissance, leveraging its genius location and unique Egyptian personality, and taking into consideration the historical phase to achieve sustainable development for a better standard of living for all Egyptians. Mainly depending on science, knowledge, and innovation, Egypt will have a competitive and diversified economic system and a social system characterized by participation, solidarity, and justice as well as a balanced ecosystem that preserves the human and natural resources gifted to Egypt by Allah." (Egypt Vision 2030, n. d.).

On that premise, the lens by which the Primary 4 Science curriculum is analyzed in this study is Education for Sustainable Development (ESD). According to Leicht (2018), ESD allows every human being to acquire the knowledge, skills, attitudes, and values necessary to shape a sustainable future. It is the contribution of education to prepare and equip students to achieve the SDGs. ESD gives learners of all ages the knowledge, skills, values, and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality (UNESCO, 2023). According to González-Salamanca et al. (2020), ESD is a holistic and transformative form of education that covers various aspects such as content, learning outcomes, pedagogy, and the learning environment. It emphasizes the importance of equipping individuals with the necessary knowledge, skills, values, and attitudes to actively engage in sustainable development initiatives. To achieve this, ESD calls for an action-oriented

pedagogy that encourages self-directed learning, active participation, collaboration, problem-solving, and interdisciplinary and transdisciplinary approaches. These pedagogical approaches are crucial for developing the essential competencies required to foster sustainable development in the twenty first century. The term “ESD Competencies” is explained through different frameworks in the literature. The definition of Competencies is defined according to the Curriculum Framework for SDGs as “: the amalgam of attitudes, knowledge, values and skills acquired as a result of learning” (Osman et.al, 2017, p.10), which is a reference for the rubric adopted for the analysis in this study. “Competencies” rather than “skills", are used in the context of ESD, as it refers to a broader scope of skills, alongside the knowledge and values needed that can be achieved through learning (Rieckmann & Barth, 2022). Several frameworks of ESD competencies have been reviewed, the ones explained in detail in the literature review section are: “Framework for Education for Sustainability: Enhancing Competences in Education” developed by Juuti et al. (2021) and published by the Erasmus, European Union, “The Learning Design & Education for Sustainable Development, CoDesignS” (QAA & Advance HE, 2021), and finally, The Rounder Sense Of Purpose (RSP) framework, that is considered for both students and educators for pre-service or in-service training for ESD (EU, 2019).

The reason for choosing ESD as the basis for the analytical framework of the analysis of this study is because it is an approach to equip students to tackle real-world challenges and because it is a novel concept in Egypt. It is evident from the literature review process that reference to ESD in Higher Education (HE) is more abundant than that in K-12 Education in Egypt. A study by El-Sherbiny et al. (2022), provides insight into the implementation of ESD in higher education institutions (HEIs) in Egypt, other studies for example by Biltagy, (2022), ElMassah et al., (2020) and Mousa et al., (2019) address different issues related to ESD in HEIs. As for ESD integration in K-12 education in Egypt, much less literature indicates its practice and application in schools, except for one project “Edu Camp” which stands for “education for sustainable development beyond the campus’ and aims to introduce key sustainable development principles into teaching and learning in the Egyptian public schools (Sewilam et al., 2014). Another study relating to ESD

in Egypt by EL-Deghaidy (2012), which introduces science teachers to sustainable development and highlights the importance of teachers in promoting ESD practices in schools, affirms that the daily practices of the individuals are far from what the country needs.

Although the first mention of ESD as an approach to Education was back in 1992 at the Earth Summit in Rio de Janeiro (Servaes, 2016), it still did not gain proportional attention to its importance and impact on education in Egypt. Despite participating in numerous professional development programs throughout my teaching career since 2013, I only first encountered ESD during a course I chose to take as part of my Master's program at the American University in Cairo in the fall of 2022, which was pivotal in expanding my understanding of how education can contribute to sustainability.

Now, in 2023, this new Science Curriculum for Primary Four has been in effect for two academic years, the current academic year 2023/2024 being its third. I wanted to analyze the science curriculum from an ESD perspective especially since we live in a fast-changing world that holds uncertainty of how the course of the current challenges will unfold, or what new challenges will emerge. The curriculum does not claim its inclusion of ESD, however, EDU 2.0 is based on Egypt Vision 2030, where SDGs are at the forefront of development, and hence, features of ESD are expected to be considered.

The literature review presents the findings as well on the curriculum types and objectives (Kelly, 1977). The “Curriculum as Product” focuses on the learning outcomes of education, while “Curriculum as Process” positions teachers as facilitators of knowledge production and value identification. It is the process, along with the product, entailing preparation, teaching, and assessment, that defines the resulting curriculum, is the curriculum type of interest in the context of ESD (Vare, 2022). This type of curriculum is not only focused on the content but on the methodology of its delivery as well.

Science Education (SE) is claimed to be an impactful tool for education in general and ESD in specific. SE has been linked by Newton (1988) to the notion of “relevance”. In 1982, the National Science

Teachers' Association (NSTA) in the USA declared that the problems that we face today can be solved only by persons educated in the ideas and processes of science and technology and that scientific literacy is basic for living, working, and decision-making (Stuckey et al., 2013). The intersection between ESD and SE is considered an evolution of what was popular in the early 1990s as Socio-Scientific Issues (SSIs) (Sadler & Dawson, 2011). The principles of good quality science education and ESD are aligned as explained in section (2.5.5).

The analysis in this study is contextualized within the alignment between the outcomes of good-quality Science Education and ESD, framing the curriculum as both a "Process" and a "Product," recognizing its dynamic nature in facilitating learning experiences ("Process") while also focusing on achieving specific outcomes or objectives ("Product")

1.2 Problem Statement

A considerable number of Egyptian graduates lack the skills needed for the local and global job markets, which is manifested by a "skills gap" which is attributed to the lack of focus on skills acquisition through the learning process (Roach, 2022). Skills that are needed for today's students to function at work and in society and to be successful at personal and professional levels must be incorporated into school curricula in a comprehensive manner (González-Salamanca et al., 2020). ESD is a discipline that provides a framework for educators on how students can be prepared with the competencies to tackle Sustainable Development Challenges by providing them with competencies needed for their lives and careers (Rieckmann, 2022). Case studies from different countries in Europe (Iliško & Badyanova, 2014), and Canada (Lee & Efird, 2014) affirm that ESD enhances the quality of education and has a positive impact on the development of nations. However, this discipline is still novel to the practice of education in Egyptian schools. The first introduction was in 2010 through the EduCamp project that was funded by the EU (Sweilam, 2012), (see section 2.7.4).

Based on the notion that good quality SE aligns with the principles of ESD (McComas et al., 2005), therefore, good quality SE is foundational to promoting ESD competencies. The quality of teaching skills through science is unsatisfactory in Egypt (Bahatheg, 2019). Egypt scored below average in the TIMSS in 2019 (TIMSS & PIRLS International Study Center at Boston College, n.d.). A study (EL-Deghaidy, 2015) affirms that SE in Egypt has a multitude of challenges: the presence of limited resources, inadequate infrastructure, and overcrowded classrooms, with student numbers exceeding sixty in certain instances, in addition to the prioritization of mass education over quality. Despite the attempts to reform education manifested in "Edu 2.0" since 2018, challenges in the application of its goals still exist (Moustafa et al., 2022).

1.3 Purpose of the Study

This study aims to analyze the newly developed Science curriculum of Primary 4 under the EDU 2.0 reform program of the MOETE that was launched in 2018, as part of "Egypt Vision 2030". The focus is on exploring the extent to which the curriculum integrates ESD competencies from a curriculum design and the teachers' application perspectives. Due to the novelty of the curriculum at hand (first introduced in 2021), and the lack of ESD knowledge and practice in Egypt, there is a research gap in the area that is aimed to be tackled through this study.

1.4 Research Questions

This study aims through this qualitative analysis of the science curriculum of Primary four to answer the following Research Questions (RQs):

RQ1: To what extent does the design of the newly developed Science Curriculum of Primary 4 integrate ESD Competencies?

RQ2: To what extent are Science teachers teaching this curriculum familiar with and applying ESD Pedagogies?

The interplay between science education and ESD in the curriculum, is the essence of this study, tapping into the notion of the overarching purpose of education being meaningful and providing citizens with the competencies that can help them tackle real-world challenges on the global, national, and personal levels, manifested in ESD. The integration of ESD in the curriculum in this study is analyzed through Document and Content analysis of the Science Techbook, in addition to looking into the teaching practices of the teachers gathered through teacher interviews to identify what pedagogies, tools, resources, and learning environment are provided to help facilitate that curriculum.

1.5 Review of Related Studies in the Literature.

Similar studies have been found in the literature. A study in Iceland by Jóhannesson et al. (2011) examined how ESD is addressed in the Icelandic public school curriculum for early childhood, compulsory, and upper secondary education. The researchers developed a key to identify indications of ESD across the three curricula. The key promotes a comprehensive perspective on sustainable development, addressing economic, environmental, and social factors as interconnected rather than separate domains. It was constructed to align with the objectives of the United Nations Decade of Education for Sustainable Development (2005-2014) and drew upon research on Environmental Education and ESD. The key encompasses seven characteristics: values, attitudes, and emotions regarding nature and the environment; knowledge that contributes to the responsible use of natural resources; well-being and public health; democracy, participation, and action competence; equality and multicultural considerations; global awareness; and economic development and prospects. By employing this key, the researchers identified various signs and indicators within the curricula that provide opportunities for teachers and schools to address sustainable development issues. The similarity of this study to the current study is the alignment of the key

that the researchers have developed; where the seven characteristics used as indicators for the ESD competencies can be clustered under knowledge, skills, and values which are the core reference used for the analysis in this study as explained in the analytical framework (section 3.1.1).

In another comparative study for content analysis of curricula in China and the United States by Miao et al. (2022), the research focused on analyzing the curriculum standards for geography in middle school and high school as the primary data sources. The objective was the investigation of ESD literacy in the learning objectives of these curricula. The analysis encompassed a total of 239 learning objectives in China and 165 learning objectives in the US allowing for a comprehensive content analysis to be conducted according to the coding framework obtained from the SDG 4.

A content analysis for an elementary Science curriculum was conducted in Turkey by Dimirci (2017) that aimed to examine the incorporation of sustainable development into the curriculum. The investigation sought to analyze the extent to which sustainable development was embraced within the curriculum and its potential contribution to achieving national sustainable development goals. To achieve these objectives, a content analysis of the textbooks and curriculum objectives was examined to gain insights into how the national elementary science education objectives and textbooks incorporate the concept of sustainable development. Additionally, the study explored how the objectives of each chapter within the curriculum align with the principles of sustainable development. The conceptual framework for the analysis of this study was explained in that paper.

A study was conducted by Tatlilioglu (2019) in the Middle East Technical University in Turkey, on the analysis of a Science Curriculum for grades five to eight. The study adopts the rubric (Osman et. al, 2017) which is one of the rubrics used for this study looking into the integration of ESD in terms of knowledge, skills, and values.

The following chapter explains in detail the different aspects included in this study, drawing from the literature definitions and evidence for good quality education, science education, curriculum, and ESD, presenting the intersection between these aspects. The chapter ends with the theoretical framework that relies mainly on the constructivist views connecting it with the guidelines and pillars of ESD and Science Education.

The keywords that were used for researching the literature: Education, Education for Sustainable Development, Science Education, Sustainable Development Goals, Content Analysis, Science Curriculum, and Education 2.0, Egypt Vision 2030.

Chapter 2: Literature Review

This chapter presents the philosophical and theoretical underpinnings of the "good quality" related to the aspects of the topic; education in general, its purpose and impact on different levels, personal, societal, and economic with the ultimate goal of empowering individuals to tackle and solve real-world challenges. Defining the real challenges in this study in the context of Sustainable Development Goals (SDGs), giving a comprehensive overview of the history of its evolution beginning with the Brundtland Report until the United Nations (UN) Agenda 2030. Then shedding light from the literature on ESD, as an approach to address the SDGs 2030, referring to the evolution of the approach, the different frameworks, and their efficiency in addressing SDGs. Then tackling the "good quality" of Science Education, referring to its positioning in the literature as an impactful tool to address real-world challenges helping students to be more motivated and prepared with the knowledge and skills that enable them to do so. Also, referring to the intersection between ESD and Science education, through the pedagogies and theoretical constructivist underpinnings as their roots.

After clarifying from the literature, the interplay between those three pillars; ESD, Science Education and the Curriculum, the context of Egypt is presented, describing the education system, the reform that started with Egypt being one of the countries participating in the UN Agenda of 2030, and Education 2.0 (EDU 2.0), as the reform project of the education sector as part of the development plan in the Egypt Vision 2030. There is a reference to the practice of ESD in Egypt, highlighting the one project referred to in the literature which is EduCamp.

2.1. What is the Purpose of Learning?

Learning is a natural process, in which humans acquire skills and construct knowledge through experience, which leads to change in behavior. Education, however, is the structured and purposive arrangement of learning (Hannon, 2015). Philosophers and educators over history such as Aristotle, Plato, John Dewey, and others, have posed this question “What is the purpose of Learning?”. Plato built his system of education on a fundamental belief in truth and on the conquest of truth by rational knowledge (Hannon, 2015). In the early 1900s, Dewey’s view on education was centered on the belief that education is based largely on experience, thinking, and reflection and that students must interact freely in their environments to construct knowledge. (Darder et al., 2023). There are different views on the purpose of education. Watson (2016) raised epistemological questions concerning the aims, nature, and practice of education. To achieve that, he reviewed the different views of philosophers on the aims of education and discussed the areas where they agreed and disagreed. He then summarized the debate over this discourse in three dominant schools of thought that can be identified in contemporary discourse. These three schools are relevant to the theoretical framework of this study that draws on Social and Cognitive Constructivism, as well as the analytical framework that is used for the curriculum analysis under three categories: Knowledge, Skills, and Values. Watson (2016) labeled them the Goods-Based, Skills-Based, and Character-Based accounts of the aims of

education. In each type of the three, he refers from literature to the theorists in education in ancient and modern times that backed this type of education.

Goods Based Education; suggests that its proper ends are epistemic goods such as truth, knowledge, and understanding. This aligns more with the Platonic view on knowledge and learning. For goods-based theorists, the emphasis is placed on the transmission and acquisition of epistemic goods as education's most 'characteristic' goal. Another version of goods-based education highlights "understanding" as the ultimate good that needs to be the aim of education rather than just the padding of knowledge and truth.

Skills-based Education identifies the skills of the learner, as opposed to the epistemic goods they acquire, as the primary educational objective (Watson, 2016). Advocacy of skills-based education has been prominent through the critical thinking movement, in the 1970s, and is now well-established in the philosophy of education, drawing on different frameworks and pedagogies that emphasize the importance of teaching skills. (Watson, 2016).

Character-Based Education: Watson (2016) refers to two types of character education; The Moral and the Intellectual Character. Moral Character-based accounts suggest that the proper aim of education is the nurture and cultivation of character traits or virtues in the learner (Watson, 2016). As with skills-based education, character-based accounts take "the learner" as the educational focus rather than the goods they acquire. Character education has advocated the cultivation of moral and/or civic character traits such as kindness, justice, and honesty claiming they are essential to producing good citizens and members of society (Watson, 2016). Character education theorists view that the acquisition of knowledge and skills should come secondary to the aim of building character through education. The criticism of this account entailed the pivotal role of knowledge and understanding to build character, and this has given rise to the "Intellectual Character Education", as another type of character education, serving the aim of education. (Watson, 2016). This assures the notion that there is a plurality of educational aims and that they can be complementary to each other rather

than distinctly separated from each other. It also provides answers to a wide range of pedagogical questions concerning the scope and content of the curriculum, the nature, and many others will depend significantly on which of these approaches one adopts (Watson, 2016).

The purpose of education; as a structured way of learning is not static, but rather dynamic, aligning with the nature of the evolution of humans, their environments, and hence, their needs. Valerie Hannon (2015) revisited the question "What is the purpose of Education?" and proposed four levels of learning related to the greater challenges and possibilities that we face as a species**.** Hannon (2015) suggests that learning's purpose is to secure our survival under variable conditions and thus has clustered the challenges that education needs to address in four clusters: Global, Local/National, Intrapersonal, and Interpersonal.

According to Hannon (2015), at the Global Level, in terms of the physical planet and the people given the extensive presence of globalization, everyone has to learn to live within the earth's renewable resources. Education should serve the purpose of preparing responsible consumers, that have respect, appreciation, and tolerance when dealing with the Earth's resources. Also, education should prepare humans with the knowledge and the skills that help them interact with each other in a way that ensures a peaceful co-existence of all humans on Earth. As for the National/local. Hannon (2015) linked this level with the national economy, highlighting the importance of educating citizens with the skills required to embrace the change of jobs, careers, fields, and skill sets. Entrepreneurship education and creativity will be crucial skills for survival in a fast-changing world. Learning to make a living successfully and contribute to the new economies will entail learning to think and act 'green, lean, and eco'. It will also mean learning to adapt to work with automation, and with co-workers who are robots. At the Interpersonal level**;** education should take into account the challenges that threaten the connectedness of people within the society; such as the rise of digitalization which led to isolation, the rise of dysfunctional families, and the demographic changes that are creating more aging societies. Finally, at the Intrapersonal level, the notion of self-enhancement will take a different turn in the

future given the changes in longevity. Education should prepare students to take responsibility for their own bodies and adopting healthy lifestyles is mandatory for later well-being. Dignity and social engagement, as well as highlighting the importance of spirituality where mindfulness and spiritual connectedness will be more needed in the highly technological, fast-moving modern world (Hannon, 2015).

The idea of linking the purpose of education to real-world challenges, especially related to sustainability, is at the heart of this study, as it assumes that the ultimate purpose of education is to provide individuals with the set of knowledge, skills, and values that help them tackle real-life challenges in their personal and career life, build their nations and contribute to the development and the prosperity of societies. Challenges in this study are framed as the Sustainable Development Challenges of the UN Agenda 2015 (UN,2015).

2.2 The World Challenges from the Brundtland Report to the SDGs

As explained in the previous section, the ultimate purpose of education is solving real-life challenges. Current and future challenges have been a global priority for decades. The term “Sustainable Development” was first introduced in the Brundtland Report in 1987 and is defined as: “being able to meet the needs of the present (socially, economically, environmentally), without compromising the ability of future generations to meet their needs (Brundtland, 1987). There was consensus on the concept of “Sustainability”, as an approach in a collective concept to address the different challenges that face all the nations of the world (Servaes, 2016). This report was the outcome of the World Commission on Environment and Development which was created as a sub-organization of the UN, that was later named the “Brundtland Commission”. This commission was created in 1972 at the UN Conference on the Human Environment (Hajian & Kashani, 2021). It is evident that the attempts of the world nations to collaborate to tackle the challenges facing the planet are over 40 years old now, however, environmental challenges were the main concern in those early attempts. The idea of sustainable development was first introduced as a strategy against a potential ecological disaster resulting

from the extreme commercial exploitation of resources and the deterioration of the environment. The main aim was to maintain the environment (Hajian & Kashani, 2021). The challenges, however, have evolved over the years (Servaes, 2016). After the dissolving of the Brundtland Commission in 1987, the "Center for Our Common Future" was founded in 1988, taking the outcomes of the Brundtland Report, presenting the different environmental and developmental challenges, as their agenda (Servaes, 2016). The summit that took place in 1992, was another milestone in the evolution of the challenges, during the "Earth Summit" in Rio de Janeiro, and was considered at the time as the largest environmental conference organized in which 30,000 participants attended (Hajian & Kashani, 2021). The outcomes were also mostly focused on environmental-related issues, and the highlight of the outcomes was "Agenda 21" which shed light on the importance of having the countries develop strategies for sustainable development. In the year 2000, the Millenium Summit was held, offering a more clear and mature direction and strategy of how the nations can collaborate on environmental problems, clearly highlighting the pivotal role of businesses, local governments, and civil society (Servaes, 2016). Eight Millennium Development Goals (MDGs) were set to be achieved by the year 2015 (Hajian & Kashani, 2021). In September 2015, the UN 2030 Conference was held, where the 17 SDGs were announced to be the new agenda adopted by the 193 participating countries and to be fulfilled by 2030. (*Transforming Our World: The 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs*, n.d.). Figure 2.1 shows the evolution of the world challenges from the Brundtland Report to the SDGs

Figure 2.1

Timeline for the evolution of the SDGs from 1972 to 2015.

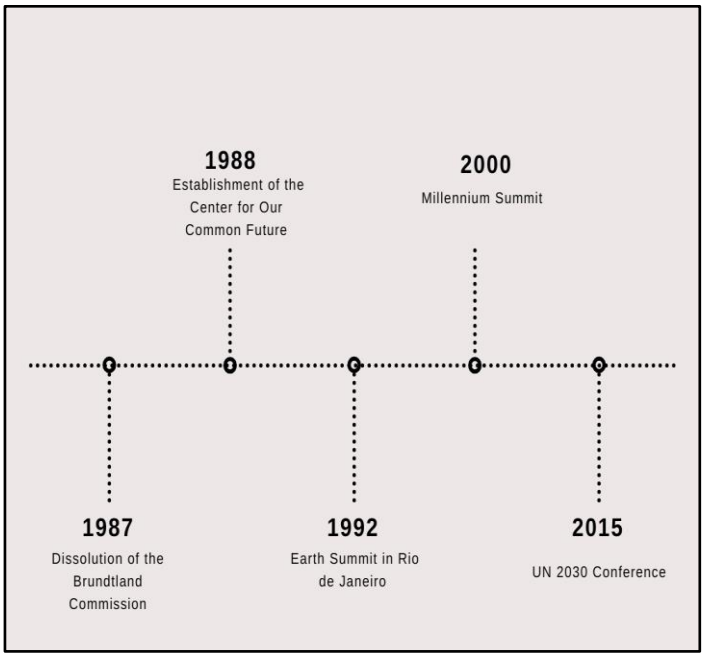


Figure 2.2.

The 17 SDGs

Source: UN, 2023

2.3. The Curriculum

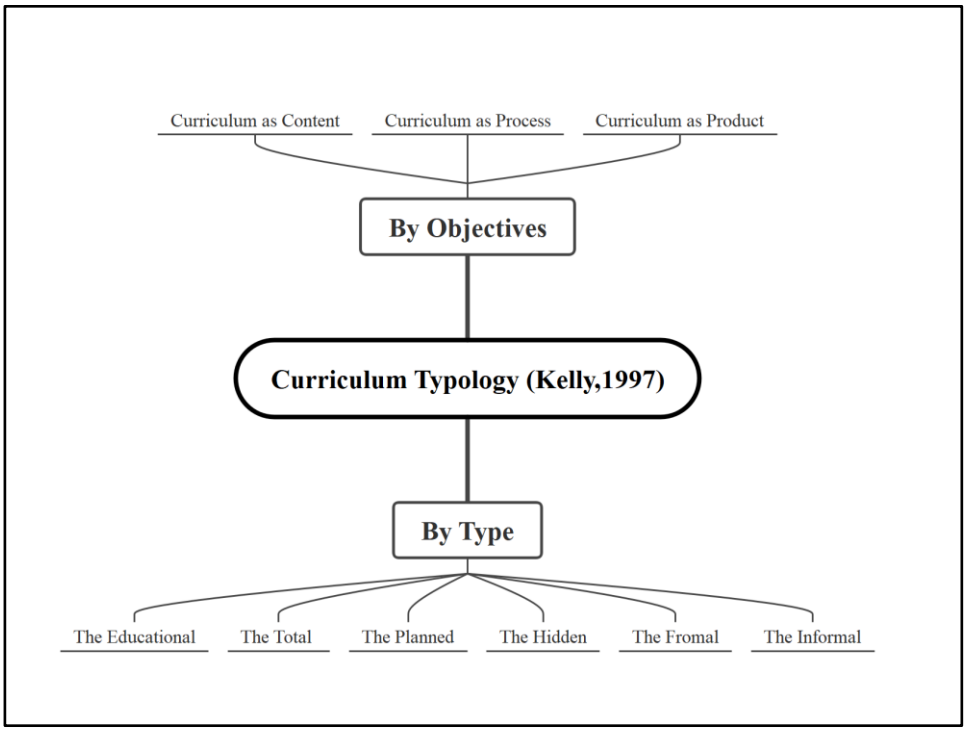
It is necessary to provide an operational definition of the Curriculum in this study, which analyzes a Science Curriculum for the integration of ESD. David Scott (2007) stated that the curriculum can refer to a system at many levels including national, institution, or school, and that it has four dimensions, including aims or objectives, content or subject matter, methods or procedures, and evaluation or assessment. According to Kelly (1977), understanding the curriculum is complex and cannot be defined in one definition, hence, he provided a comprehensive "typology" for the curriculum, taking into consideration the different important aspects of any educational process that would help define each type, such as the learning objectives, outcomes, content, teaching methods, and others. The following definitions are the ones necessary for the current study to relate later to the types of ESD types (ESD 1 and 2) and will be referred to later in the discussion of the analysis:

- The Educational Curriculum can be, and is, used, for many different kinds of programs of teaching and instruction (Kelly, 1977, p.2).
- The Total Curriculum is the curriculum offered by a school, and the curriculum received by individual pupils, should not be simply a collection of separate subjects.
- The Hidden curriculum refers to those things that students learn at school because of the way in which the work of the school is planned and organized, and through the materials provided, but which are not in themselves explicitly present in the planning; e.g. learning about social roles.
- The planned curriculum is what is laid down in syllabi, whereas the actual or received curriculum is the reality of the students' experience.
- The formal curriculum denotes the formal activities for which the timetable of the school allocates specific periods of teaching time, and the informal curriculum denotes the informal activities that go on, usually on a voluntary basis, at lunchtime, after school hours, at weekends, or during holidays that are referred to as "extra-curricular activities" (Kelly, 1977, P.7). It is important that educators give equal attention to the hidden curriculum as the planned one.

Kelly (1977) has also provided 3 types of Curricula based on its objective; Curriculum as Content, which is focused on the body of knowledge. Curriculum as a Process refers to the facilitation by teachers and the "how" of the knowledge meant to be transferred. Finally, Curriculum as Product focuses on the learning outcomes of the learning. Figure 2.3. shows the different categorizations of the curriculum as per Kelly (1977).

Figure 2.3

Different Categorizations of the Curriculum (Kelly,1977).



The principal objective of a quality curriculum is to enable students to acquire and develop the knowledge, skills, values, and associated capabilities and competencies, to lead meaningful and productive lives (Stabback, 2016). Key indicators of curriculum success include the quality of the learning achieved by students, and how effectively students use that learning for their personal, social, physical, cognitive, moral, psychological, and emotional development. (Stabback, 2016). The development of students depends on competencies or capabilities, such as critical and creative thinking, and depends on the integration of three broad learning domains: knowledge, skills, and values (OECD, 2019)**.**

There is an interplay between knowledge, skills, attitudes, and values in any curriculum (OECD, 2019). ‘knowledge’, refers to content knowledge, or to propositional, or declarative, knowledge, including, both theoretical and empirical knowledge. ‘Skills’ refers to procedural knowledge, and includes, for example,

cognitive and non-cognitive skills, hard and soft skills.‘Values’ refers to dispositional knowledge, and includes, for example, attitudes (which are consequent on the values we hold), moral dispositions, and motivation, will and commitment. Values are the guiding principles that underpin what people believe to be important when making decisions in all areas of life (OECD, 2019). They determine what people will prioritize in making a judgment, and what they will strive for in seeking improvement (OECD, 2019). SDG 4.7 focuses on universal values, such as “justice”, “equality”, “dignity” and “respect”, as well as aptitudes for “networking and interacting with people of different backgrounds, origins, cultures and perspectives”, and behavioral capacities to “act collaboratively and responsibly to find global solutions for global challenges”, and to “strive for the collective good” (United Nations, 2015, p. 17). Hence, “Knowledge”, “Skills” and “Values”, are the skeleton of the analytical framework designed for this study (See section 3.1.1)

2.4. Education for Sustainable Development (ESD)

2.4.1. The Evolution of ESD

Literature has emphasized that achieving the SDGs will not be sufficient without changes to societies’ dominant values, beliefs, and consciousness (Leicht, 2018). In general, ESD was first explained in Agenda 21 at the Earth Summit in Rio de Janeiro in 1992 and has been described as “an education that allows every human being to acquire knowledge, skills, attitudes, and values necessary to shape a sustainable future” (Leicht, 2018). It is the contribution of education to prepare and equip students to achieve the SDGs (Leicht, 2018).

(ESD) as described by UNESCO on their website:

> *“ESD gives learners of all ages the knowledge, skills, values, and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality. It empowers learners of all ages to make informed decisions*

> *and take individual and collective action to change society and care for the planet. ESD is a lifelong learning process and an integral part of quality education. It enhances the cognitive, socio-emotional, and behavioral dimensions of learning and encompasses learning content and outcomes, pedagogy, and the learning environment itself*." (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2023)

ESD is different from mainstream education in terms of its impact on the learners and society (Vare, 2022). It is different as well from Environmental Education (EE) and is considered as the evolution of EE (Karaarslan-Semiz, 2022). There has been some ambiguity over EE regarding its objectives and outcomes up until the publishing of "Goals for Curriculum Development in Environmental Education" in the Journal of Environmental Education in 1980 (Karaarslan-Semiz, 2022) where the explanations of the goals helped clarify and prioritize the objectives and outcomes of EE. Sund (2022) has linked the evolution from EE to ESD to "Teaching Traditions" (the habitual choices that teachers make and that reflect their teaching philosophy). The three traditions are as follows:1) The fact-based tradition formed in the 1960s, where knowledge of science was fundamental for solving environmental problems. The assumption was that Environmental problems caused by humans would disappear if everyone in school was taught scientific knowledge, 2) The normative tradition emerged during the 1980s. It links the knowledge that people have about the environment to their values and their lifestyles. The teaching content requires interdisciplinarity between science and other social sciences. Close attention is paid to the use of students' everyday experiences and attitudes when creating teaching examples and assignments, 3) The pluralistic tradition developed during discussions in the 1990s with the Rio de Janeiro Earth Summit in June 1992. Environmental issues are viewed as moral and political and are conflicts between different human interests. Science does not provide guidance on how to act when it comes to these issues, this is when there was a need for EE to include a spectrum of social and economic development and was replaced with the concept of ESD (Sund, 2022).

ESD is a combination of two approaches, each underpinned by its philosophy (Vare, 2022);

> "ESD 1: promoting/facilitating changes in what we do include promoting (informed, skilled) behaviors and ways of thinking, where the need for this is clearly identified and agreed upon – this is learning for sustainable development. ESD 2: building capacity to think critically about (and beyond) what experts say and to test sustainable development ideas including exploring the contradictions inherent in sustainable living – this is learning as sustainable development" (Vare, 2022, p.182)

The combination of both types is the inclusive meaning of ESD, and it is what promotes individuals who are critical and informed, and that aligns with the concept of "competency-based education" (Vare, 2022).

Karaarslan-Semiz (2022), demonstrates that the seeds of ESD were planted in the UN document Agenda 21 and identified four major goals: 1) improving the quality and access to basic education, 2) reorienting existing education 3) increasing public understanding and awareness of sustainable development and 4) developing training for all sectors (UNCED, 1992, p.32). Nowadays, ESD is at the core of all 17 SDGs, which aims to create a sustainable future for our planet and empower all people to take responsibility for creating this sustainable future together (UNESCO, 2014). The relevance of ESD is explicitly recognized in the SDGs as part of Target 4.7:

> "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development". (United Nations, 2015, p. 17)

The key goal of ESD is to develop students' sustainability competencies so that they can contribute to the transformation of society for sustainability (Rieckmann, 2022). The following paragraphs explain ESD as 'Transformative Education' and ESD as 'Competency-based education'.

2.4.2. ESD as Transformative Education

Transformative Education is defined by UNESCO (2023) as, "an element of quality education and a crucial enabler for sustainable development. It empowers learners of all ages with the knowledge, skills, values, and attitudes to address the interconnected global challenges we are facing, including climate change, environmental degradation, loss of biodiversity, poverty, and inequality. It builds a sense of belonging to a common humanity and helps learners become responsible and active global citizens in building inclusive, peaceful, and sustainable societies. It contributes to the achievement of the Sustainable Development Goals (SDG) and makes part of the SDG Target 4.7 on ESD" (UN, 2023).

Transformative Education is based on the Transformative Learning Theory (TLT), first proposed by Mezirow (1997). Although the foundation of the theory was linked to adult education or "andragogy", it has become more popularly used by scholars when referring to k-12 education, especially ESD and Global Citizenship Education (GCED) (UNESCO).

2.4.3. ESD as a Competency-Based Education

ESD should enable all people to contribute to sustainable development. Therefore, it aims to develop key competencies that are relevant for sustainable development, but which most people still lack (Rieckmann, 2018). The rise of Competency-Based Education and Technical Education (CBET) began in the United States (US) in the late 1960s, in the space race between the US and the Union of Soviet Social Republics (USSR) (Vare, Lausselett, et al., 2022). According to Vare, Lausselett, et al., (2022), it was realized that focusing only on content was not yielding the desirable results of education, positioning the US behind the USSR and more focus on the outcomes was required. CBET is education that focuses on the outcomes of learning in the form

of acquired competencies which has made CBET an approach strongly linked to ESD (Vare, Lausselett, et al., 2022).

2.4.4. ESD Competencies Frameworks

Several frameworks have been proposed in the literature to be a guide for applying ESD. Examples of these frameworks are:

1) Framework for education for sustainability: enhancing competencies in education developed by Juuti et al. (2021), and published by the Erasmus, European Union. It encompasses educational concepts that diverge from traditional syllabuses and approaches. Instead of focusing on subject-specific content knowledge, competency-oriented teaching emphasizes the development of problem-solving strategies, concepts, and abilities for social action in learners. They serve as overarching and transversal learning objectives necessary for addressing the intricate challenges of our present-day reality, as highlighted by UNESCO (2017). The competencies defined within this framework are: Systems Thinking, Strategic Competency, Anticipatory Competency, Normative Competency, and Interpersonal Competency which implies social knowledge and skills (communicating, deliberating, negotiating, collaborating, leadership, pluralistic and trans-cultural thinking, and empathy). Interpersonal competence is the ability to understand, embrace, and facilitate cultural and societal diversity (Juuti et al., 2021,p.17).

2) The “Rounder Sense of Purpose (RSP)” Framework, which is considered for both students and educators for pre-service or in-service training for ESD (EU, 2019). To foster RSP, educators must possess sustainability competencies themselves and possess the ability to cultivate these competencies in their learners. This entails having a critical understanding of sustainable development and the pedagogical approach of ESD. To effectively implement the RSP model, educators should employ an action-oriented and transformative pedagogy that encourages participative, systemic, creative, and innovative thinking and acting processes, as exemplified by the activities found on the RSP website. Furthermore, educators need to

adopt a critical perspective and be capable of assessing and evaluating learner development in this domain. It is essential to acknowledge that the RSP competencies are interrelated and mutually reinforcing, thus they should not be considered in isolation. Figure 2.4 shows the framework of the RSP.

Figure 2.4.

The Framework of the RSP.

Thinking Holistically	Envisioning Change	Achieving Transformation
Integration:		
Systems The educator helps learners to develop an understanding of the world as an interconnected whole and to look for connections across our social and natural environment and consider the consequences of actions.	Futures The educator helps learners to explore alternative possibilities for the future and to use these to consider how behaviours might need to change.	Participation The educator helps learners to contribute to changes that will support sustainable development.
Involvement:		
Attentiveness The educator helps learners to understand fundamentally unsustainable aspects of our society and the way it is developing and increases their awareness of the urgent need for change.	Empathy The educator helps learners to respond to their feelings and emotions and those of others as well as developing an emotional connection to the natural world.	Values The educator develops an awareness among learners of how beliefs and values underpin actions and how values need to be negotiated and reconciled.
Practice:		
Transdisciplinarity The educator helps learners to act collaboratively both within and outside of their own discipline, role, perspectives and values.	Creativity The educator encourages creative thinking and flexibility within their learners.	Action The educator helps the learners to take action in a proactive and considered manner.
Reflexivity:		
Criticality The educator helps learners to evaluate critically the relevance and reliability of assertions, sources, models and theories.	Responsibility The educator helps learners to reflect on their own actions, act transparently and to accept personal responsibility for their work.	Decisiveness The educator helps the learners to act in a cautious and timely manner even in situations of uncertainty.

(Source: EU, 2019, p.1)

One of the ESD frameworks that is used as a major reference in this study, is the Learning Design & Education for Sustainable Development the CoDesignS (*CoDesignS ESD - Education for Sustainable Development*, n.d.) is one of the sources that were used for developing the analytical framework of the study. It is described in detail in section (3.3.1).

2.4.5. ESD Pedagogies

According to Eilam and Trop (2010), the integration of ESD pedagogies requires the inclusion of four fundamental elements that synergistically fulfill the purpose of ESD which is the acquisition of knowledge, skills, and values tackling the cognitive, socio-emotional, and behavioral domains. These four elements are "Academic Learning", "Multidisciplinarity", "Multidimensional Learning" and "Emotional Learning".

Academic Learning is described as "Natural" rather than "Non-natural", that is not bound by the closed space of the classroom. Multidisciplinarity is where learning is theme-based as knowledge of the theme is combined from a variety of disciplines, which enhances Systemic Thinking and the formation of linkages between the cause and effect between the different systems. As Systemic Thinking is an element concerned mostly with the cognitive aspect concerned with "Knowing the World", it is not necessarily related to changing behavior and hence, Multidisciplinarity is an important parameter in ESD but alone, it has little influence on changing behavior. Multidimensional Learning refers to the consideration of the aspects of time and space in the learning process, making connections related to space and time in the different systems. Students knowing the history of things helps them think creatively and develop contextual ways of thinking, it still however does not tackle the behavioral and socio-emotional domains. This is why Emotional Learning is crucial to be considered along with the other three aspects. It is the inclusion of emotions in learning activities that develop ethics and lead to behavioral change.

Also, according to Eilam and Trop (2010), the fulfillment of these elements cannot happen without a Constructivist Learning approach. The Pedagogies that are considered derivatives of these four elements are Student-Centered Learning, Minds on – Hands-on – Learning, and Active Participation.

Student – centered Learning, is when students are engaged in the construction of knowledge autonomously. This pedagogy is achieved when both the analytical and emotional skills are activated during the learning process. Interdisciplinarity is at the core of student-centered pedagogies, such as Project-Based

Learning, where students are given the opportunity to understand, engage with knowledge, and make connections on their own.

Hands-On Learning, refers to the opportunities given to the students to learn " vis a vis" firsthand, by experimentation and inquiry about real-world challenges. Mind – On Learning, on the other hand, refers to the cognitive and metacognitive skills associated with the hands-on element of inquiry. The minds-on element is essential for students to activate their emotions regarding the inquiry, which allows for reflection and development of ethics.

Active Participation is achieved when the learning stimulates the cognitive and emotional aspects of a specific issue with the objective of directing them to feel strongly about it and hence be empowered to take action. This pedagogy nurtures the "Action Competencies" that are later explained in the UNESCO ESD Learning Objectives guide in section (3.3.1), which are the Normative Competency and the Self Awareness Competency.

The next section of the literature review explains how the elements of good quality Science Education are aligned with the elements and pedagogies of ESD.

2.5. Science Education (SE)

Since the curriculum at hand for analysis is a science curriculum, good quality Science Education is synthesized from the literature tapping into different aspects of Science Education, drawing from the literature descriptions of the Nature of Science (NOS), Relevance in SE, and Scientific literacy principles, and explaining how they align with ESD principles.

2.5.1. The Evolution of SE

DeBoer (2000) demonstrates the evolution of science education showing that over the course of a century, it has undergone significant transformations. In the early 20th century, SE was influenced by educational philosophers like John Dewey, leading to the recognition that SE, along with education in

general, is closely intertwined with social life. Consequently, the role of SE was defined as equipping individuals with the competence to effectively navigate the social world, integrating scientific knowledge into real-life activities. From the 1960s to the 1980s, SE increasingly emphasized the strategic role of scientific knowledge in society. During this time, the focus shifted in the United States and Europe towards nurturing citizens who possess an understanding of science and hold positive attitudes toward scientists. SE further evolved by incorporating science and technology education to address the needs of everyday life and society. The direction of SE has continued to evolve in response to advancements in science and technology, as well as societal concerns. Presently, industrial and economic developments, as well as digital technologies, exert a significant influence on SE.

2.5.2. The Nature of Science (NOS)

The ‘Nature of Science,’ (NOS) is used to describe the intersection of issues addressed by the philosophy, history, sociology, and psychology of science as they apply to and potentially impact science teaching and learning (McComas et al., 2005).

According to El Nemr and Tolymat (2020), The NOS refers to the epistemology of science, as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge. They assume that if the content and methods of science education do not represent the nature of science, science teaching, and learning will be negatively simplified to just the narration of scientific findings and conclusions, making the processes of scientific inquiry be replaced by superficial "activities". Accordingly, science teaching will be more exams oriented to just satisfy the official "National Standards”. In this case, the student will view science as disconnected topics and pieces of information and will not be able to apply science to real-life applications (El Nemr & Tolymat, 2020).

The NOS taps into the notion that science education should be connected to life practice and applications and should help students acquire skills to tackle those challenges.

2.5.3.“Relevance” in Science Education

The literature review related to science education was focused on the notion that it should cater to acquiring the knowledge, skills, competencies, and values that can help solve problems in the real world. On that premise, the compiled literature review is focused on “relevance” in science education, the importance of context-based education in science, and teaching competencies through science education.

As mentioned earlier in the introduction section, my experience in education is mostly in science teaching. As a science teacher, I have always seen that the most important element is for students to be able to relate the concepts taught to their life applications. The literature suggests that making science learning relevant both to the learner personally and to the society in which he or she lives should be one of the key goals of science education. “Relevance,” is one of the most affecting features of the quality of science teaching (Newton, 1988). Science teachers should build their plans for teaching based on their students’ experiences. Teaching science should be human-centered, where the students’ needs and aspirations are a priority in teaching (Newton, 1988). Relevance is inherent in the philosophy of John Dewey (1956) as well.

Stuckey et al. (2013), have brought the arguments from the literature about the theories and factors underpinning “Relevance” and bringing all these arguments together, they suggested three basic dimensions of the relevance of science education, with each having a spectrum from present to future worth, and from intrinsic to extrinsic points of view, which are the individual dimension relating to the person’s curiosity, interests and intellectual skills. The Societal dimension, which prepares students to be self- determined and lead responsibly through the understanding of science. Finally, the vocational dimension, which prepares students for their careers.

King and Ritchie (2011) argue that for science teaching and learning to be relevant, it has to be given a context, and this is why the “context-based” pedagogies, became very popular in science education, such as Project Based Learning (PBL), Inquiry-Based learning and others, that give a context to the concept being

taught, to make it relevant to students by creating links between what the students study and their everyday lives. This increases the student's motivation, engagement, and personal satisfaction with their learning and also increases their awareness of the social implications of what they study, which makes them better informed about career options.

Relevance in Science education to societal issues was applied in the approach that was popular in the 1990s called "Socio-Scientific Issues" (SSI), which directs the learning of science to cater to tackling these issues through acquiring the needed skills and knowledge (Stuckey et al., 2013). The term SSI was used in the science education literature as early as 1986, but it did not mature into a framework for research and practice until the late 1990s when much of the early work related to SSI focused on learner practices in the context of SSI (Sadler & Dawson, 2011). For example, how students negotiate information provided in reference to SSI, engage in argumentation regarding SSI, conceptualize the nature of science in the context of SSI, and apply science content knowledge in the negotiation of SSI. Nowadays, this approach is strongly connected with the philosophy of ESD in the sense that both approach societal, economic, and ecological goals through education (De Haan, 2006).

2.5.4. Competence in Science Education

As mentioned earlier, ESD is a Competence-based education, and it was discussed that Competence-based education focuses on students' learning outcomes rather than on what teachers should be teaching. In the context of Science Education, Kauertz et al. (2011) define competence as a developable capacity to detach science-specific cognitive processes and knowledge from one situation and apply it to scientific problems in a social setting as described by the OECD. He also suggests that there are 3 aspects that play a role in achieving competence through science education; these are the Content, Cognitive, and Science literacy aspects.

As for the Content aspect, Kauertz et al. (2011) argue that school science content typically includes knowledge, typical procedures in science like modeling and experiments, or argumentation, and meta-

knowledge about the nature of science and scientific inquiry where curricula and educational standards are the basis for the selection of content and the description of desired competencies. Concepts and mental models are structured by the big ideas of science which are described as basic concepts in science, for example, energy and matter (Kauertz et al., 2011). The role of experiments for school science embedded into scientific inquiry is essential for learning science and also fosters argumentation, logical reasoning, and communication skills (Zimmermann 2005). Kauertz et al. (2011) also argue that Meta-knowledge, which is beliefs and knowledge about knowledge in a certain domain, is also part of science content in school and described it as the NOS.

Cognitive aspect: Kauertz et al. (2011) argue that it is not intelligence that determines a successful performance, but cognitive abilities are more important, and they related these abilities to the levels of Benjamin Bloom's Taxonomy (1956). So, problem solving for example is a cognitive task that requires knowledge from the scientific aspect.

Scientific Literacy as defined by the OECD is:

> *"The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity."* (OECD 1999, p. 60)

Therefore, competence from a scientific literacy perspective is the ability to detach science content from situations, the ability to apply strategies in various contexts, and to use mental models in different settings (Kauertz et al., 2011).

2.5.5. Intersection between Science Education and ESD

It is assumed from the literature that science teaching can help promote skills by encouraging inquiry, investigation, analysis, and evaluation (Zorluoğlu & Güven, 2020). SE should cultivate individuals who possess scientific literacy, encompassing comprehension of science content, the ability to draw conclusions from scientific issues, and the skills to evaluate scientific cases (Wang & Wang, 2011). Other studies such as DeBoer (2000) and Teksöz (2016) affirm that same ideology. According to Feldman and Nation (2015), there has been a growing interest in integrating sustainability into science teacher education. This recognition stems from the understanding that sustainability issues require a comprehensive understanding that encompasses the social, environmental, and economic dimensions of sustainability. Consequently, it can be inferred that the content and purpose of SE in the 21st century align with those of ESD.

The primary objective of ESD is to equip students with the competencies necessary to address real-world challenges, a goal that closely aligns with the objective of Science Education, which aims to assist students in effectively navigating the social world by integrating knowledge into practical, real-life activities (McComas et al., 2005). ESD competencies, which are categorized under the Cognitive, Socio-Cultural, and Behavioral domains, correspond to the skills intended to be acquired through the understanding of the Nature of Science (NOS) and Scientific Literacy.

The four fundamental elements of ESD; Academic learning, Multidisciplinarity, Multidimensionality, and Emotions—along with key pedagogical approaches such as Student-Centered Learning, Hands-on Minds-on Learning, and Active Participation (Eilam & Trop, 2010), are all encompassed within the principles of NOS. Furthermore, the concept of Relevance in Science Education emphasizes the necessity of context-based learning that relates to sociocultural issues (SSIs), aligning with the interdisciplinary nature of ESD. Additionally, the notion of Competence in Science is rooted in the content, cognitive, and scientific literacy

aspects of education, emphasizing the application of scientific knowledge to solve real-world challenges. As a conclusion, the objectives and pedagogies of ESD and Science Education are aligned and hence, ESD competencies are expected to be integrated as a natural outcome of good Science Education.

2.6. The Theoretical Framework

The study focuses on the integration of ESD competencies in the curriculum design and the application of ESD pedagogies. Two theories are selected: Constructivism, which forms the foundation of the curriculum design, and Self-Determination Theory explains the motivation and Self-efficacy of teachers that affect their application to constructivist pedagogies.

Constructivism, entailing its social and cognitive aspects, aligns with the principles of ESD Pedagogies (Eilam & Trop, 2010) as explained in section (2.4.5). As per Piaget (1952), individuals, especially children, develop knowledge through their interactions with the environment. These interactions encompass both physical actions, such as manipulating objects, and mental processes, like refining existing mental structures. Initially, when encountering a new object or concept, individuals attempt to fit it into their existing cognitive frameworks. However, if the new experience challenges these frameworks, cognitive imbalance, or disequilibrium, occurs, prompting individuals to adjust their mental structures through a process known as accommodation. Through accommodation, new cognitive structures are formed to incorporate the new information, temporarily restoring equilibrium. Nevertheless, cognitive disequilibrium recurs whenever individuals encounter experiences that cannot be easily assimilated, thus driving the ongoing construction of knowledge.

According to Zang (2005), Constructivism focuses on reflection and active processing of new information. It is a learner-centered approach in which learners make sense of information by processing it in relation to prior knowledge to construct an interpretation. Constructivist approaches require a more hands-on approach by the instructor, moving from direct instruction of information to facilitator of interpretation. The

creation of knowledge comes from a continuous interaction between the instructor and learner and from learner to learner, focusing on the learner's interpretation Constructivism highlights the interaction of persons and situations in the acquisition and refinement of skills and knowledge where its key assumption is that people are active learners and develop knowledge for themselves (Schunk, 2012). It emphasizes that it is important for students to study a topic from multiple perspectives in what is referred to as the "integrated curriculum" (Schunk, 2012) This aligns with the basis of ESD recommending multi-disciplinary ways of teaching. Teachers should structure situations in a way that learners become actively involved with the content through the creation of materials and social interactions that challenge their thinking and force them to rearrange their beliefs, conducting more activities that are based on constructivist approaches such as observing phenomena, collecting data, generating and testing hypotheses, and working collaboratively with others (Schunk, 2012). On that premise, this theory fits as a theoretical framework for this study, which focuses on the interplay between knowledge, skills, and values to change beliefs and behavior accordingly.

As for the theoretical framework related to teachers' application, "Self-Efficacy", which is the teacher's aptitude to facilitate desired educational outcomes or influence students' learning, is foundational to explaining teachers' performance (Klassen et al., 2010). According to the social learning theory of Bandura (1999), self-efficacy is the individual's belief in their capacity to organize and execute the requisite actions to achieve specific goals (Bandura, 1999, p. 3). Self is acknowledged as a potent motivator of behavior and demonstrates strong associations with task engagement decisions, exertion levels, and perseverance (Gardner & Pierce, 1998). According to Pauw et al. (2022), educators exhibiting elevated levels of general teaching self-efficacy are inclined to explore diverse instructional methodologies, embrace innovative teaching materials, demonstrate higher levels of professional dedication and yield enhanced student achievement outcomes (Bray-Clark & Bates, 2003). Self-efficacy is the deductive category of analysis that is used in the analytical framework used for designing the interview questions, specifically

related to the “values” strand related to the set of Knowledge, Skills, and Values that teachers have to apply ESD Pedagogies (explained in section 3.3.1).

As the motivation of teachers is an impacting factor of self-efficacy, Self Determination Theory (SDT), is chosen for comprehending the factors that support or hinder intrinsic motivation, extrinsic motivation, and psychological well-being, all of which are directly related to educational environments. According to Ryan & Deci (2020), SDT highlights individuals' intrinsic motivations for learning and personal development, emphasizing how these innate tendencies can be nurtured and supported. The theory is based on three main ideas; 1)Autonomy: The need to feel a sense of choice and control over one's actions and behaviors, pursuing activities aligned with personal values and interests.2)Competence: The need to feel effective and capable in interactions with the environment, seeking opportunities for skill development, mastery, and accomplishment, and 3)Relatedness: The need to feel connected and valued by others, forming meaningful relationships and experiencing a sense of belongingness and social connection. According to Hakanen et al. (2006), teachers' motivation to apply constructivist pedagogies influences their instructional practices, professional development efforts, responsiveness to student needs, persistence in overcoming challenges, and ultimately, the engagement and achievement of their students.

2.7. The Context of Egypt

2.7.1. The Education System in Egypt

The Egyptian education system is divided into five levels; preschool education (age 4-6), primary education (age 6-11), preparatory education (age 12-14), secondary education (age 15–17), and higher education (age 18+) (Sewilam et al., 2014). The primary and preparatory levels are incorporated together in what is called ‘Basic Education’. There are 27.3 million students in the pre-university education stages in 70.1 thousand schools and public Azhar institutes (CAPMAS, 2022). The student-to-teacher ratio has increased, and many teachers cannot provide up-to-standard learning experiences (Moustafa et al., 2022). Accordingly,

the classroom environment in Egypt tends to be teacher-centered, and textbook-dependent, and emphasis is placed on rote learning and exams (Sewilam et al., 2014). The unsatisfactory conditions in the Egyptian education system were reflected in international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS). Egypt ranked in the bottom 5% in PIRLS 2016 and ranked 130 out of 137 in the World Economic Forum's Global Competitiveness Report in 2017–2018 (Olson et al., 2008).

According to Moustafa et al., (2022), several reform strategies, policy changes, and national programs have attempted to improve Egypt's education system. Except for the "Community School Program", most of these reforms focused on improving access, pedagogies, and teachers' training. There was much less focus on the outcomes, developing students' competencies, and improving curriculum development. Also, there was an isolation between these reforms in education and the socio-economic conditions of the country, the policies lacked coherence with the country's strategic objectives.

2.7.2. Egypt's Vision 2030

Egypt's Vision 2030 was developed in alignment with the UN SDGs 2030 and is currently aiming to implement a comprehensive curriculum reform, transform instruction, develop both teachers' professional and technical skills, and restructure assessment (PwC, 2019). The end goal is to ensure "a high-quality education available to all, without discrimination, based on efficient, just, sustainable and flexible institutional framework, and providing the necessary skills to students and trainees to think creatively, get empowered technically and technologically in addition to contributing to the development of a proud, creative, responsible, and competitive citizen who accepts diversity and differences, and is proud of Egypt's history" (Egypt's Vision 2030, n.d.).

2.7.3. Education 2.0 (EDU 2.0) - The Education Reform

A new educational vision was set to conform with Egypt's 2030 Vision seventh pillar and the constitutional mandate to recognize education reform as one of Egypt's top priorities (Moustafa et al., 2022). To enact this vision MOETE launched a reform initiative known as Education 2.0 (EDU 2.0) that came into effect in 2018 to revamp K-12 schooling all over the country. EDU 2.0 reforms started with Kindergarten (KG)1, KG2. KG1 was launched in 2018, followed by KG2 in 2019, and will continue with the rollout until 2030 (Marey & Maged, 2022). Before the launch of EDU 2.0, international and national partnerships were established among Discovery Education, National Geographic Learning, Nahdet Masr, Longman Egypt, UNICEF, UNESCO, the World Bank, and experts from the MOETE Center for Curriculum and Instructional Materials Development (CCIMD). The science curriculum that is analyzed in this study is the updated one for primary four, under the EDU 2.0 is adopted from and published by "Discovery Education '' and was contextualized by the curriculum development team in the CCIMD of the Egyptian MOETE. The first introduction to this curriculum was in the academic year 2021/2022.

The objective of the EDU 2.0 strategy in its early years of implementation is to transform education in early grades to be "competency-based," focusing on the classroom experience of learners, when in parallel, EDU 1.0, also offers some reform actions to students already in the system (Moustafa et al., 2022). EDU 2.0 shifts toward student-centered learning, with more emphasis on skills and values than knowledge, learning that is less theoretical, but more relevant to students' lives. Moreover, it is based on providing teachers with supportive instructional materials (as the techbook used for this study) and professional learning, promoting digital learning, and eliminating test-based learning and instruction (Marey & Maged, 2022). These life skills equip students with holistic and lifelong learning and assist them in making meaning out of knowledge and transferring these skills, values, and knowledge to their self-development, work, and social life (UNICEF, 2020). In terms of technology, the Egyptian Knowledge Bank (EKB) was launched in 2016 as an electronic hub hosting prominent international publishers, making digital learning accessible to all Egyptian learners,

teachers, and researchers, transforming text-based learning into digitized curricula, and supporting online learning. (Marey & Maged, 2022).

2.7.4. ESD in Egypt

The literature about ESD in Egypt has more publications related to its integration into Higher Education but is limited when referring to K-12 education. Since the goal of ESD is to cater to achieving sustainability and tackling sustainable development issues, it is needed more than ever before in Egypt, given the challenges the country is currently facing. A study by Sewilam et al. (2013), emphasizes that among these challenges is the economy which is largely based on high levels of production and resource consumption. Overuse of resources has led to the extinction, not only of certain animal and plant species, fresh air, or water but also of cultural heritage. Air quality in Egypt is deteriorating particularly in Cairo and Alexandria as Egypt's total carbon dioxide (CO2) emissions represent some 1 % of the total world emissions which is high in comparison with other industrial countries due to overuse of fossil fuels. Egypt is now facing an energy crisis, its natural gas consumption nearly doubled over the last decades and the total petroleum consumption has risen by about one-third over the same time with Egypt relying mainly on oil and natural gas as its main energy sources. Both the quality and quantity of water in Egypt are problematic due to the unsustainable usage of the Nile water and the disposal of municipal and industrial solid and liquid waste

The initiative to integrate ESD in Egyptian schools as found in the literature refers to the "Edu Camp project". It is a European–Egyptian project and stands for "education for sustainable development beyond the campus" which aims to introduce key sustainable development principles into teaching and learning in the Egyptian public (Sewilam et al., 2014). The RWTH Aachen University in Germany together with Egyptian and European partners initiated a project funded by the European Commission entitled 'EduCamp: education for sustainable development beyond the campus" The main objective of EduCamp was to promote and implement ESD nationwide and beyond all education levels, but with an emphasis on public schools (Sewilam

et al., 2014). According to Sweilam (2014) who was the head of the project at the time, the project was introduced with ESD being a new concept to teachers in Egypt along with ESD material aligned to the national curriculum. One of the challenges faced in the project was the large class size constraining teachers to apply ESD pedagogies. Although the ESD kits (with materials for activities) were provided to teachers, it was challenging to apply with 60 students in the class. The other major challenge was in the assessment system, affecting teachers' attitudes and pedagogies, to be more instruction-led than interactive and student-centered (Sewilam et al., 2014).

2.7.5. Science Education in Egypt

A study (EL-Deghaidy, 2015) that aims to investigate how SE can be customized to meet ecological and societal purposes in Egypt, affirms that SE in Egypt has a multitude of challenges; the presence of limited resources, inadequate infrastructure, and overcrowded classrooms, with student numbers exceeding sixty in certain instances, in addition to the prioritization of mass education over quality. Moreover, the uniform provision of textbooks in schools for each subject every September, coupled with the official syllabus defined by the Ministry of Education that specifies the monthly unit to be taught, along with regular visits by MOE inspectors to ensure adherence to the prescribed material, collectively portrays an image of a bureaucratic education system (El-Deghaidy, 2015).

Chapter 3: Research Methodology

This section explains the data collection and analysis process of this study. The objective is to analyze the integration of ESD competencies in the newly developed curricula under EDU 2.0. The curriculum at hand, the Egyptian Science Curriculum of Primary Four, is used for the analysis as a case study, where the findings can be an indicator of the extent of integration of ESD competencies in the newly developed curricula. The analysis is done in two dimensions; the analysis of the designed curriculum itself (The Techbook), and the analysis of the insights of teachers teaching this curriculum focusing on their perceptions

and knowledge of ESD. The aim of this analysis is to find out whether teachers apply ESD pedagogies through the science grade four curriculum whether knowing about ESD or not but using ESD-friendly pedagogies such as Project- or Inquiry-Based Learning and others. These two dimensions give a profound reflection on the integration of ESD competencies in terms of presence in the curriculum and in terms of application from the teachers' side.

The research design seeks to answer the two research questions of the study. The different data collection tools and sources used to answer these questions are explained. The basis of the analysis using the different tools, the analytical framework developed by the researcher, is presented and explained.

3.1. Research Design

This is a qualitative study whose central phenomenon is to explore how Sustainable Development Goals (SDGs) considering relevant ESD competencies are reflected in the newly developed curricula under the Egyptian project of Education Reform, "Project EDU 2.0." According to Clark and Creswell (2014). "Qualitative Research" is a set of procedures for collecting, analyzing, and reporting qualitative data in a study to address the research purpose. The research questions of this study are answered through a qualitative case study design. A case study research design is a set of qualitative procedures used to explore a bounded system in depth. A system can be a program, event, or activity involving individuals, and the system of interest for a particular study is referred to as the case. "Bounded" means that the researcher separates the case in terms of time, place, or some physical boundaries for the research study.(Clark & Creswell, 2014).

The digital version of the Science Techbook teachers' guide provided by the Egyptian Ministry of Education and Technical Education (MOETE) serves as the primary sample for the case study aimed at investigating the central phenomenon. Purposeful sampling is used for the selection of the sample for this study, for the choice of the curriculum to be analyzed, the criteria determined in the sample for the curriculum:

- A newly reformed curriculum under the Education Reform Project of the Egyptian MOETE – Edu 2.0

- A Science curriculum for the elementary stage, the choice of the elementary stage by the researcher is based on the assumption that competencies that are taught as early as a primary stage, can have an impact on the acquiring of these competencies by the time of graduation.

- The curriculum has been in effect for more than 2 years to the date of this study. This allows for getting a more comprehensive analysis including the changes that took place since its launch and their underpinnings.

The lens of the analysis is ESD, hence, the study explores the integration of ESD Competencies within the curriculum, focusing on Knowledge, Skills, and Values (K/S/V) associated with each Sustainable Development Goal (SDG), as well as the eight key ESD Competencies outlined by UNESCO (2017). The findings from this case study are intended to offer a broader perspective on the alignment of the EDU 2.0 curricula with the vision of reform in Egypt under the UN Agenda 2030, as discussed in the literature review section (2.7.2.).

The two Research Questions to be answered through the analysis are :

RQ 1: To what extent does the design of the newly developed Science Curriculum of Primary 4 integrate ESD Competencies?

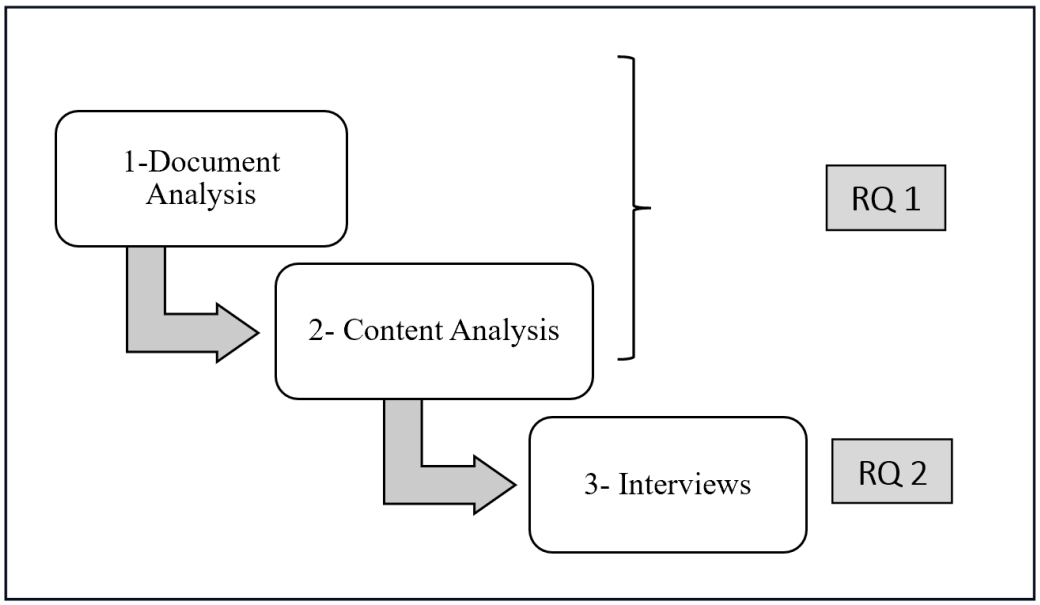
RQ 2: “To what extent are Science Teachers teaching this curriculum familiar with and applying ESD Pedagogies?”

The RQs are addressed through the data collection and analysis described in this design in three steps as shown in figure (3.1), these are Document Analysis of the Techbook, followed by the Content Analysis for

the same document, and finally the Interviews with Science Teachers and Curriculum Experts, and Developers as well as the former Egyptian Minister of Education and Technical Education (MOETE). The first two steps answer the first RQ, while the third step answers the second RQ. The Interviews included two group participants; 1) Science teachers, to complement the findings of the Content Analysis, and 2) Curriculum Experts and the former Minister of Education and Technical Education, Dr. Tarek Shawki, to complement the findings of the Document Analysis. Therefore, triangulation is achieved by the different data collection methods in the research design (Clark & Creswell, 2014). The steps of the study are shown in Figure (3.1). Involving students in the design is excluded as the assumption is they are not mature enough to reflect on their learning linking it to acquiring competencies, at this age as well as limited access to schools for study purposes.

Figure 3.1.

Steps of the Study

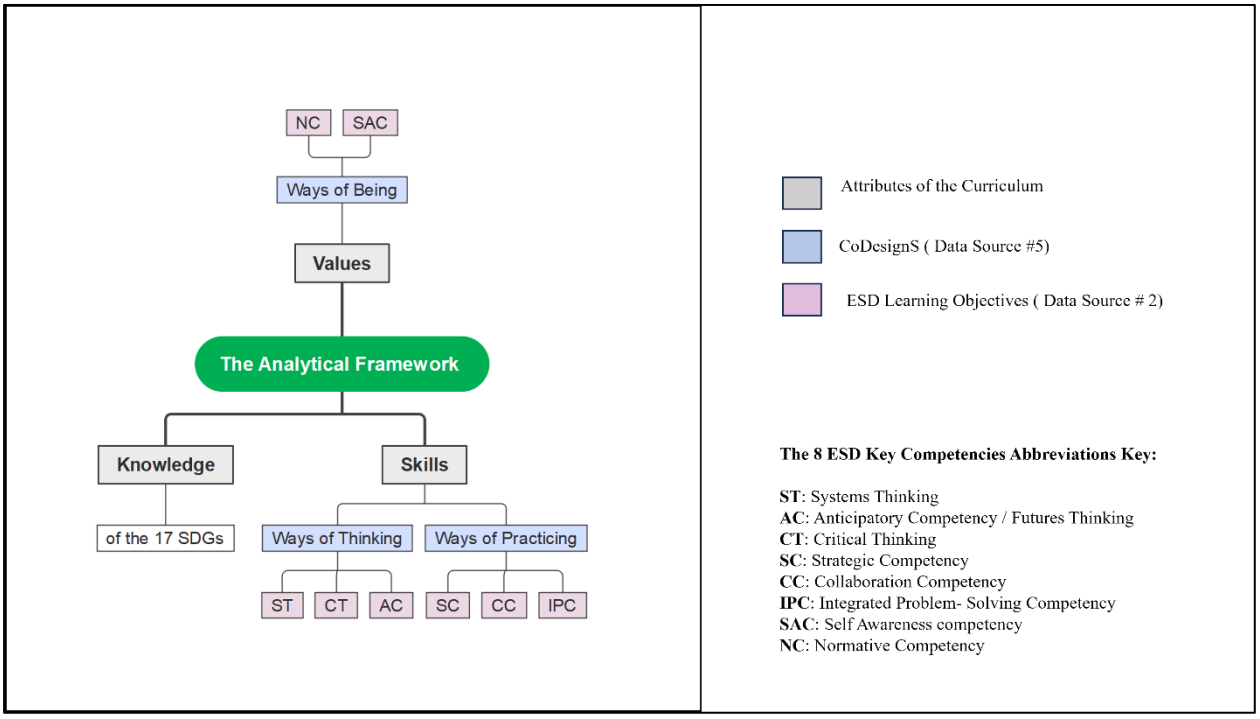


3.1.1 The Analytical Framework

The Analytical Framework I developed for the analysis of this study is based on using ESD Competencies as the lens of the analysis. The three main pillars of the analysis are the Knowledge, Skills, and Values (K/S/V) of ESD. The ESD competencies are categorized under these three pillars. This is based on the notion that these are the three main domains of any curriculum that help integrate any set of skills or competencies as referred to in the literature review section (2.3.) according to the OECD (2019). The Analytical Framework, shown in Figure (3.2), shows that" Knowledge", "Skills" and "Values", are the basis of the framework based on the notion that they are the pillars of curriculum design (OECD,2019). The knowledge skills and values sought in the analysis are those related to the SDGs present (or not) in the curriculum. The eight ESD Competencies that are intended to be analyzed in the curriculum design are outlined in the ESD Learning Objectives (UNESCO,2017). These eight competencies are : Critical Thinking (CT), Systems Thinking (ST), Anticipatory Competency (AC), Strategic Competency (SC), Collaboration Competency (CC), Integrated Problem Solving Competency (IPC), Normative Competency (NC), and Self-Awareness Competency (SAC). The operational definitions of these competencies are listed in the Data Analysis section (3.4.2). In order to categorize the eight competencies under Knowledge, Skills, and Values, another source was used, which is the CoDesignS Toolkit (*CoDesignS ESD - Education for Sustainable Development*, n.d.), which is based on the ESD Learning Objectives (UNESCO,2017), and that categorizes the eight competencies under three categories; "Ways of Thinking", that comprises the CT, ST and AC, "Ways of Practicing", that comprises the SC, CC and IPC, and finally, the "Ways of Being" that comprises the NC and SAC. This layer of categorization was added to the framework to maximize the level of accuracy that links the different competencies to the knowledge, skills, and values, minimizing the level of subjectivity in the content analysis.

Figure 3.2.

The Analytical Framework



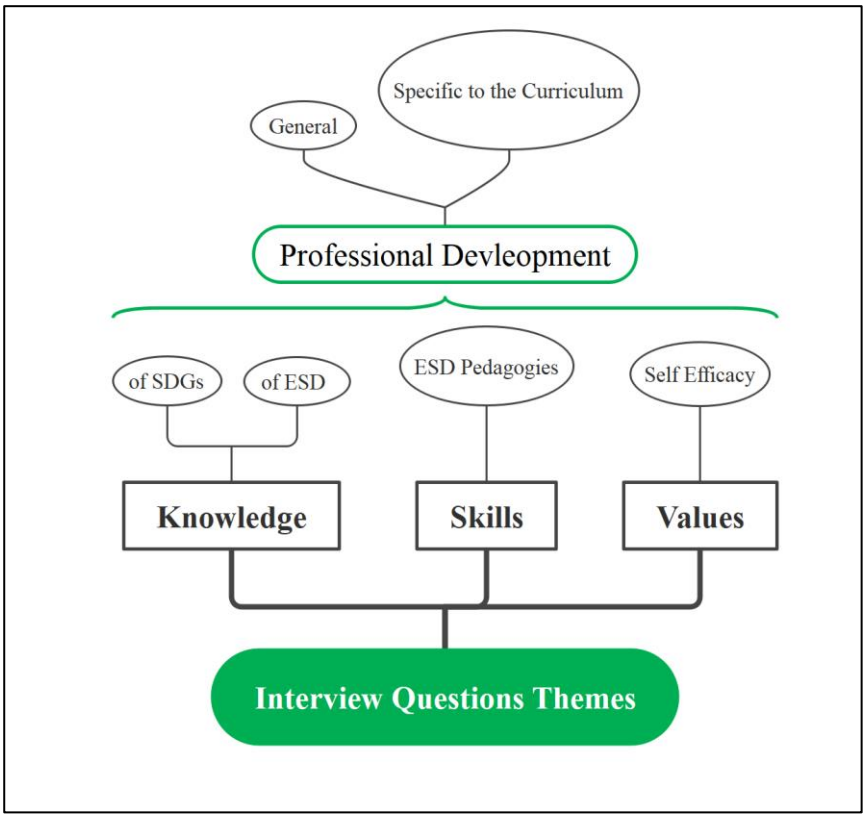
The Analytical Framework is the basis of applying the analysis through the three data collection tools as explained in the "Data Collection "section (3.3.); setting the themes to be covered through the document analysis, the development of rubrics of the content analysis, serving as the deductive categories, and finally, for creating the interview questions and the thematic analysis of the responses of the participants.

I created an adaptation of this framework to answer RQ 2 related to teachers' knowledge and application of ESD Pedagogies, (see Figure 3.3).To adapt this analytical framework to answer RQ 2, and to create the interview questions themes based on the deductive categories of this framework, the "Knowledge" in the framework is concerned with the theme of teachers' knowledge of SDGs and ESD, the "Skills" is concerned with the theme of ESD Pedagogies application, and the "Values" is concerned with

the theme of Self Efficacy of the teachers. Professional Development is added as a stand-alone theme, positioned as an overarching one that influences the themes related to knowledge, skills, and values.

Figure 3.3

Analytical Framework for Interviews Questions Themes



3.2. Participants

The major group of interest of participants in this study was recruited to answer the second research question: “To what extent do Science teachers teaching this curriculum use/ know ESD Pedagogies?” Eight Science teachers were interviewed. Seven of the teachers interviewed were females, one was male. The majority of them teach at Egyptian national private schools. It was challenging to recruit more teacher participants fitting the criteria of recruitment mentioned in the methodology section. A larger number of participants would have yielded more representation to the different school levels and teacher backgrounds as discussed in the limitations section.

Recruitment of Science Teachers was done through the Professional Educator Diploma (PED) at the American University in Cairo (AUC), by contacting student-teachers who are currently / or have been enrolled to ensure that the participants have an interest in professional development in education, specifically science education. Based on this selection, the type of sampling is "Purposeful sampling". Purposeful Sampling is "the process of intentionally selecting sites and individuals to participate in research because the researcher is purposefully selecting the sites and individuals that they include in the study. This type of sampling is best suited for qualitative research because the researcher can select the individuals who are most appropriate for a study of the central phenomenon" (Clark & Creswell, 2014, p.332)

The criteria for choosing the teacher participants were as follows:

- Science teachers in national schools, private or public, that teach the Egyptian national curriculum.
- Teachers are currently teaching or have taught this curriculum for at least 1 academic year.
- Teachers are currently / or have been enrolled in the Professional Educator Diploma (PED) at the American University in Cairo (AUC), to ensure the sample of teachers chosen have an interest in professional development in education, specifically science education.

The teachers in the purposeful sampling batch recommended other Science teachers who fit the same criteria. This was done to allow for the collection of more insights, conveniently. The objective of the teachers' interviews is to complement the findings from the content analysis, by sharing insights on their practice using the Teacher's Guide of the techbook.

The other group of interviewees consisted of curriculum experts (CE) and developers who have been members of the team working on the development of the curriculum being analyzed (The Science Techbook Teachers' Guide, 2021/2022). Purposeful sampling was adopted as well to recruit the two curriculum

experts/developers. The only criterion for recruitment was the direct involvement in the development of the curriculum being analyzed to be able to give insight into the different aspects related to the development of the curriculum beginning with the initial setting of the curriculum framework objectives, to the design and the delivery to students and teachers, including the plans for the professional development of teachers especially in the first year of launching (2021/2022). The objective of the CE interviews is to complement the findings of the document analysis, by sharing their insights on the development process and the discourse underpinning this process. Two Curriculum Experts were interviewed. One has over 20 years of experience in teaching Science and holds a supervisory position where he has detailed knowledge of the new curricula and was indirectly related to the process of development, and the second one has 5-7 years of experience in curriculum development and was directly involved with the team developing the curriculum along with the Egyptian MOETE.

Finally, the former Egyptian Minister of Education and Technical Education, Dr. Tarek Shawki, was interviewed. He was appointed as the Minister of the Egyptian MOETE from 2017 to 2022. He was appointed as the counselor of the American University in Cairo in 2023, which facilitated the accessibility to interview him. The objective of interviewing Dr. Tarek was to complement the document analysis, being the leader and the decision maker of EDU 2.0.

3.3. Data Collection

The two RQs are addressed through three data collection tools. These tools are 1) Document Analysis, 2) Content Analysis, and 3) Interviews. This section explains the tools and the corresponding Data sources used for each tool and how they address the two RQs.

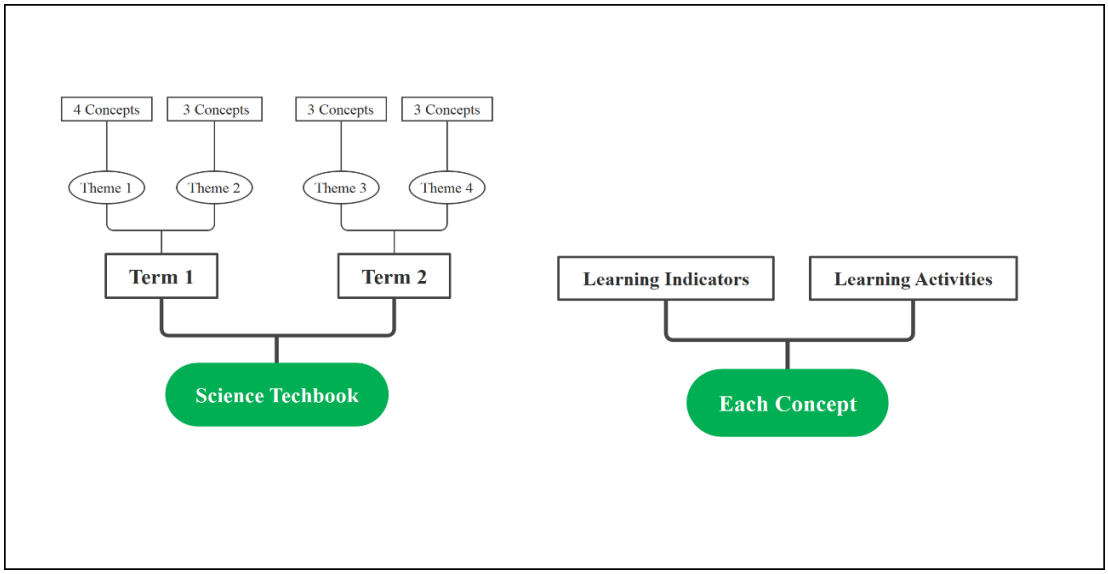
3.3.1 Data Sources

Data Source # 1 is the digital version of the Teachers' Guide for the Science Techbook for the Egyptian National Primary Four Science Curriculum. The Techbook has four units which are referred to as "Themes",

each theme has three to four "Concepts". Each Concept begins by displaying the "Learning Indicators" related to the concepts. Each Concept is presented in the Teachers' Guide version as a number of Learning Activities that are referred to in the Techbook as "Printable Resources". The Techbook is used holistically as the Data source for the Document Analysis, while for "Content Analysis", specific content from the Techbook is chosen for the analysis. The content chosen is the "Learning Indicators", and the "Learning Activities". Figure (3.4) shows an overview of the organization of the Techbook.

Figure 3.4.

An Overview of the Organization of the Techbook



Data Source #2 is "Education for Sustainable Development Goals Learning Objectives" (UNESCO, 2017). This publication by UNESCO is considered a guide for integrating and implementing ESD in any educational context.

"*The core part of the document summarizes the key competencies for learners to develop in ESD and outlines indicative learning objectives, topics, and pedagogical approaches for each of the 17 SDGs.*" (UNESCO, 2017, p.8)

"The publication intends to guide readers on how to use education, and in particular ESD, in achieving the SDGs. It identifies learning objectives, suggests topics and learning activities for each SDG, and describes implementation on different levels from course design to national strategies. The document aims to support policymakers, curriculum developers, and educators in designing strategies, curricula, and courses to promote learning for the SDGs" (UNESCO,2017, p.8)

This source is pivotal in the analysis as it has a twofold application, serving two different purposes; 1)It is used as one of the three sources to develop the Analytical framework of the study, and 2) It is used as the source to develop the rubric of the Curriculum Framework for the SDGs developed by Osman et.al (2017), and that is used as one of the rubrics for the content analysis.

This source is divided into three main sections, where the first section "Learning Objectives for the SDGs was mostly used as a reference for this study. It provides all the operational definitions related to ESD competencies and defines the eight key competencies that are chosen in the Analytical framework for the analysis of this study, Systems Thinking Competency, Anticipatory Competency, Normative Competency, Strategic Competency, Collaboration Competency, Critical Thinking, Self-Awareness, and Integrated Problem-Solving Competency. It then explains how these competencies are categorized under the three domains: The Cognitive, The Socio-emotional, and the Behavioral Domains. Then, it gives a thorough description of the learning objectives of each of the 17 SDGs under each domain. An example of SDG 13 is given in the figure (3.5)

Figure 3.5.

A Sample of the Learning Objectives in Data Source # 2

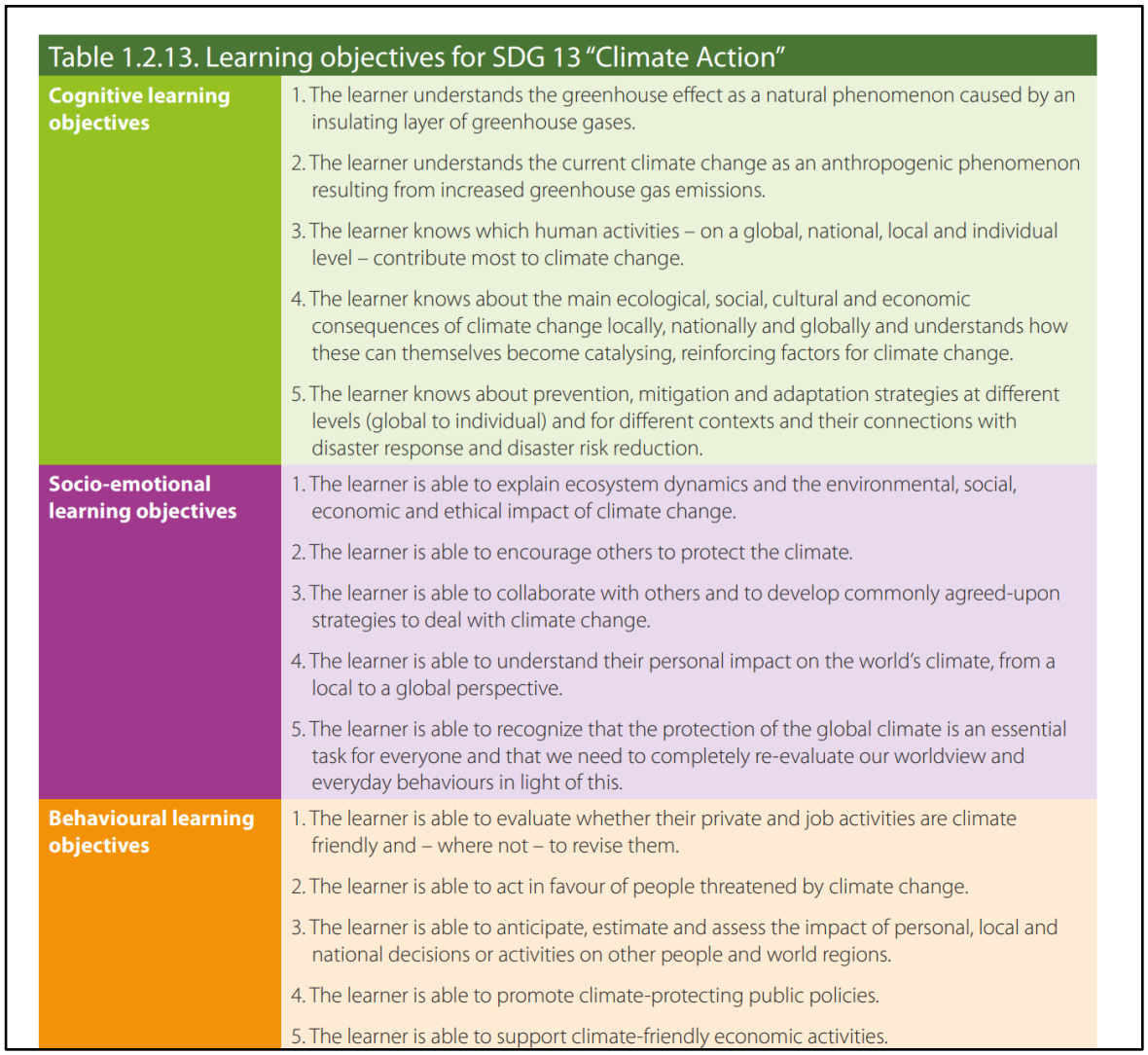


Table 1.2.13. Learning objectives for SDG 13 "Climate Action"	
Cognitive learning objectives	1. The learner understands the greenhouse effect as a natural phenomenon caused by an insulating layer of greenhouse gases. 2. The learner understands the current climate change as an anthropogenic phenomenon resulting from increased greenhouse gas emissions. 3. The learner knows which human activities – on a global, national, local and individual level – contribute most to climate change. 4. The learner knows about the main ecological, social, cultural and economic consequences of climate change locally, nationally and globally and understands how these can themselves become catalysing, reinforcing factors for climate change. 5. The learner knows about prevention, mitigation and adaptation strategies at different levels (global to individual) and for different contexts and their connections with disaster response and disaster risk reduction.
Socio-emotional learning objectives	1. The learner is able to explain ecosystem dynamics and the environmental, social, economic and ethical impact of climate change. 2. The learner is able to encourage others to protect the climate. 3. The learner is able to collaborate with others and to develop commonly agreed-upon strategies to deal with climate change. 4. The learner is able to understand their personal impact on the world's climate, from a local to a global perspective. 5. The learner is able to recognize that the protection of the global climate is an essential task for everyone and that we need to completely re-evaluate our worldview and everyday behaviours in light of this.
Behavioural learning objectives	1. The learner is able to evaluate whether their private and job activities are climate friendly and – where not – to revise them. 2. The learner is able to act in favour of people threatened by climate change. 3. The learner is able to anticipate, estimate and assess the impact of personal, local and national decisions or activities on other people and world regions. 4. The learner is able to promote climate-protecting public policies. 5. The learner is able to support climate-friendly economic activities.

Source: (UNESCO, 2017, p.36)

Each SDG is provided as well with two boxes for suggested topics to be added to the curriculum and examples of learning approaches and methods for this specific SDG as shown in figure 3.6.

Figure 3.6

A Sample for the Suggested Topics in Data Source # 2

Box 1.2.13a. Suggested topics for SDG 13 "Climate Action"

Greenhouse gases and their emission

Energy, agriculture and industry-related greenhouse gas emissions

Climate change-related hazards leading to disasters like drought, weather extremes, etc. and their unequal social and economic impact within households, communities and countries and between countries

Sea-level rise and its consequences for countries (e.g. small island states)

Migration and flight related to climate change

Prevention, mitigation and adaptation strategies and their connections with disaster response and disaster risk reduction

Local, national and global institutions addressing issues of climate change

Local, national and global policy strategies to protect the climate

Future scenarios (including alternative explanations for the global temperature rise)

Effects of and impacts on big eco-systems like forests, oceans, glaciers and biodiversity

Ethics and climate change

Box 1.2.13b. Examples of learning approaches and methods for SDG 13 "Climate Action"

Perform a role-play to estimate and feel the impact of climate change related phenomena from different perspectives

Analyse different climate change scenarios with regard to their assumptions, consequences and their preceding development paths

Develop and run an action project or campaign related to climate protection

Develop a web page or blog for group contributions related to climate change issues

Develop climate friendly biographies

Undertake a case study about how climate change could increase the risk of disasters in a local community

Develop an enquiry-based project investigating the statement "Those who caused the most damage to the atmosphere should pay for it"

Source: (UNESCO, 2017, p.37)

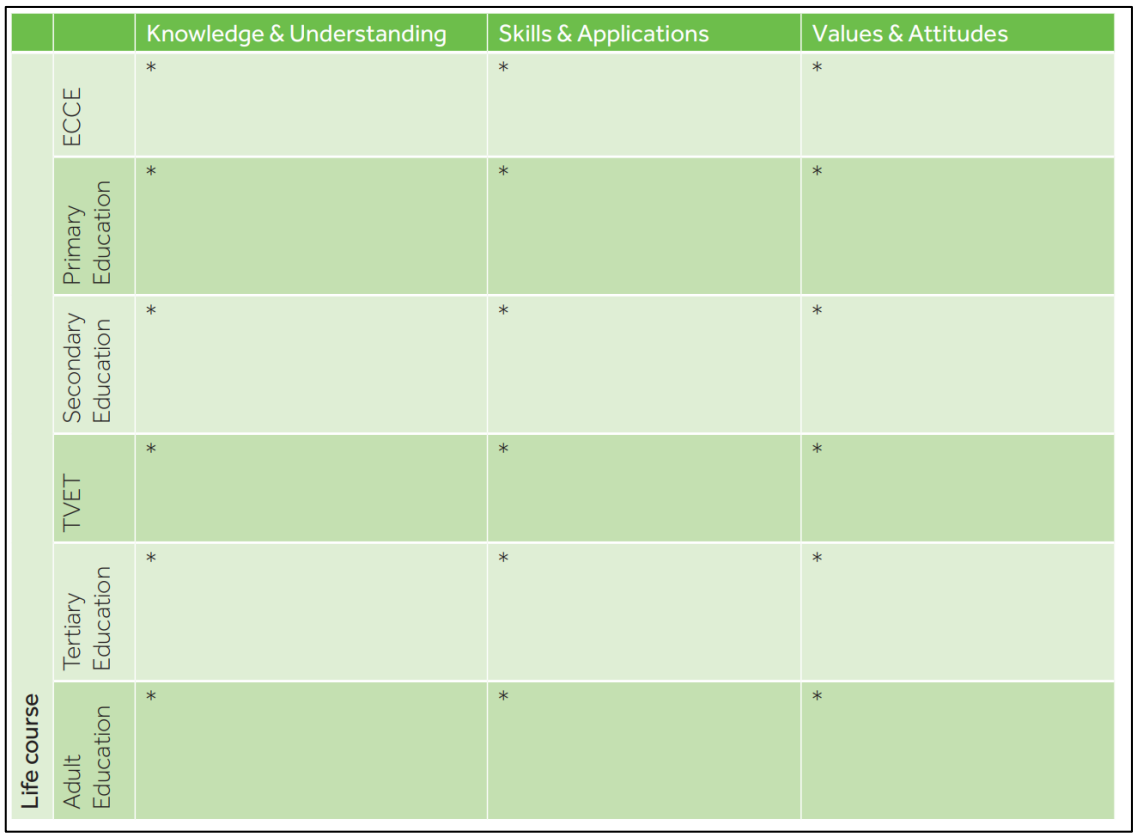
Data Source #3, the UN Curriculum Framework for the SDGs adopted by Osman et. Al (2017) is a first-edition book published by the Commonwealth. The aim of this guide as stated *"The Curriculum Framework is intended to be a flexible, non-prescriptive tool that follows a competency development model through a combination of knowledge, skills, values, and attitudes. It also aims to enable the delivery of the SDGs by*

ensuring that each population has the relevant skills, knowledge, values, and attitudes for social, economic, and environmental development, and to work in partnership to create peaceful societies." (Osman et al.2017, p.6)

This source is chosen for this study because it provides a detailed rubric with the three strands of K/S/V for each of the 17 SDGs. The framework considers "Knowledge & Understanding", "Skills and Applications" and "Values and Attitudes" as the competencies in their broad term, considering the core competencies of the UNESCO ESD Learning Objectives eight core competencies. The rubric is developed to be a reference for any course or curriculum in any educational context (non-formal, informal, and formal), and at any age throughout the life course. Thus, a matrix is presented as the three strands K/S/V being the criteria for four stages of the life course; Early Childhood Education (ECCE), Primary Education, Secondary Education, Technical and Vocational Education and Training (TVET) , Tertiary Education and Adult Education. Figure (3.7) shows a snapshot from the guide for how the matrix is presented.

Figure 3.7

A Snapshot from Data Source # 3 presenting the Matrix of the Criteria of K/S/V for 4 Stages



		Knowledge & Understanding	Skills & Applications	Values & Attitudes
Life course	ECCE	*	*	*
	Primary Education	*	*	*
	Secondary Education	*	*	*
	TVET	*	*	*
	Tertiary Education	*	*	*
	Adult Education	*	*	*

Source: (Osman et.al, 2017, p.12)

As the focus of this study is only primary education, analyzing the Egyptian Science Primary Four Curriculum, only the Elementary strand of the matrix is considered for analysis. The criteria for the Elementary Education K/S/V are extracted for each of the 17 SDGs and are presented as K/S/V per SDG serving as one of the rubrics used for the analysis of this study (attached in Appendix A). The figure (3.8.) shows a snapshot of how they are presented. This extraction process and presentation was developed by Tatlilioğlu (2019) for a study similar to this one. However, in this study aiming at mapping the ESD core competencies across the curriculum, this rubric alone was not fulfilling the purpose of this study as it refers to the K/S/V per SDG considering the eight core competencies of the UNESCO ESD Learning Objectives as mentioned in the guide, however not explicitly using them as criteria in the matrix developed. This is

why I opted for complementing this rubric with the other two sources mentioned earlier for a more reflective mapping of the ESD competencies serving the purpose of this study.

Figure 3.8.

A Snapshot from the Rubric of the K/S/V of the Learning Objectives adopted by Osman et.al.(2017)

Goal 13- Climate action (G13.)
Knowledge and understanding
K.1.Understanding of and preparedness for natural disasters (e.g. floods, tsunamis, earthquakes)
K.2.Basic understanding of climate science (e.g. carbon cycles, greenhouse gas effects) and physical impacts (e.g. sea-level rise, extreme weather)
K.3.Foundation in economic, environmental and social concepts of climate change, and how it relates to human lives (e.g. health, energy, food production)
K.4.Exploration of traditional/indigenous knowledge and culture
K.5.Concepts of climate mitigation and adaptation, resilience, sustainable development
Skills and applications
S.1.Natural-disaster preparedness
S.2.Ability to describe the causes and effects of climate change
S.3.Understand and distinguish climate change impact in relation to self/context
S.4.Analyze impacts and vulnerability in key sectors due to climate change
S.5.Impact analysis (e.g. interpret maps, graphs and statistics) across spatial and temporal scales
S.6. Understanding issues of equity and climate justice
S.7.Differentiate between adaptation and mitigation measures, and employ creative solution-finding skills
Values and attitudes
V.1.Awareness of the impacts of human activities and consequences of personal actions
V.2.Concern for and responsibility for living organisms and their environment
V.3.Motivation to make informed decisions and take responsible action
V.4.Awareness of different impacts (e.g. geographic, socio-economic)
V.5.Global citizenship

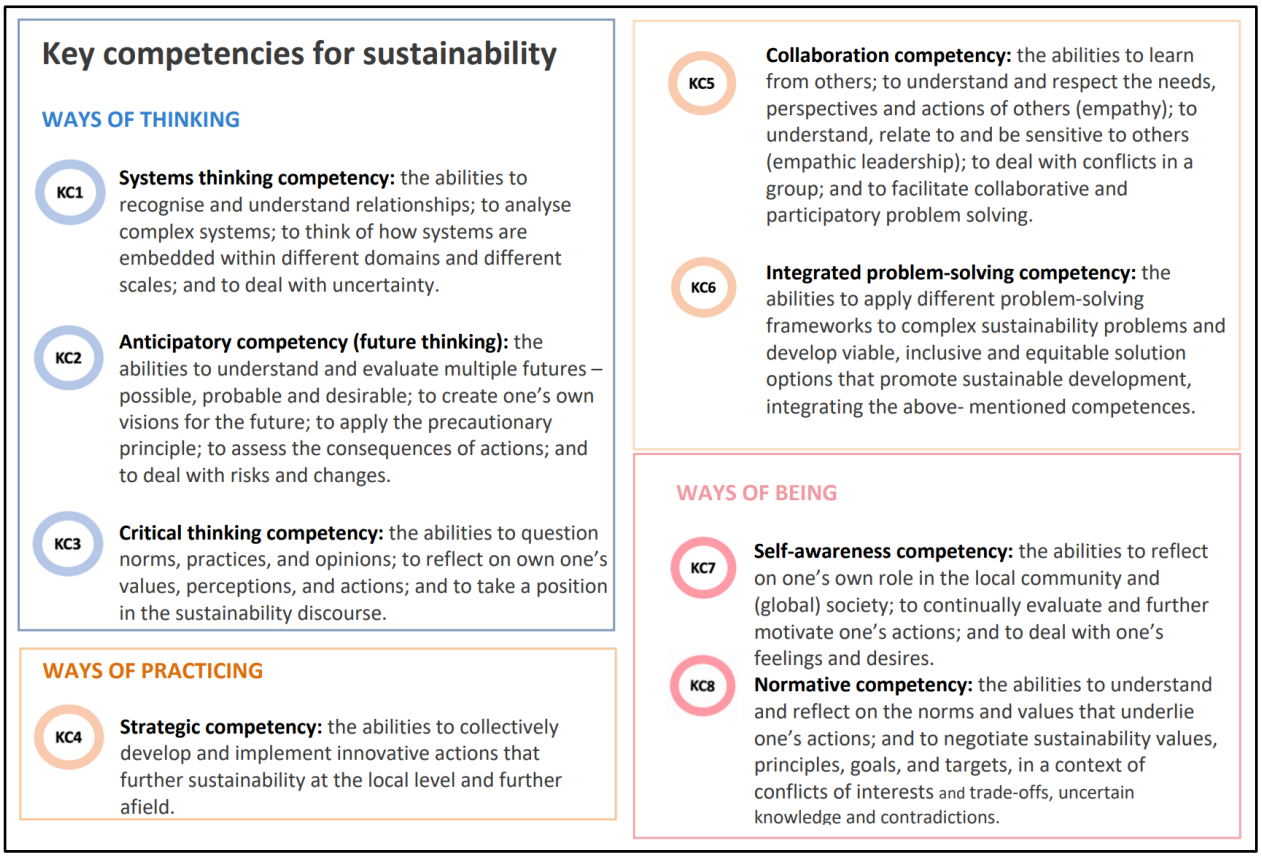
Source: (Tatlilioğlu, 2019)

Data Source #4 is the CoDesignS ESD Toolkit, which is a guide supported by UNESCO, however not endorsed by it, it developed as well based on the UNESCO ESD Learning Objectives (Data Source #2). It is designed to help all educational institutions driving formal curriculum, extracurricular activities, and lifelong learning activities within community groups.

(CoDesignS ESD - Education for Sustainable Development, n.d.). It is presented in six steps. The step of interest of use for this study is step two, where the eight competencies are categorized under "Ways of Thinking", "Ways of Practicing" and "Ways of Being" A screenshot is shown in Figure (3.9). This serves as the link between the K/S/V and the eight ESD Key Competencies, where the categorization of the Ways of Thinking and Practicing is placed under "Skills", and Ways of Being is placed under Values.

Figure 3.9

A Snapshot of Data Source # 4 Categorizing Competencies Under Three Categories



Source : (*CoDesignS ESD - Education for Sustainable Development*, 2021.,p.3)

Data Source # 5 is the interviews that were set for Science Teachers, Curriculum Developers, and the former Minister of Education and Technical Education of Egypt, Dr. Tarek Shawki. As discussed in the literature review section (2.4), there is consensus from the literature that teachers need to acquire the same attributes of ESD as those of the students (Rieckmann & Barth, 2022). This is evident in the different frameworks for teacher development and training for ESD, where Knowledge, Skills, and Values of ESD are the pillars of teacher preparedness. Also, according to Teksöz, (2016), teachers' preparedness to teach ESD lies in the notion that they have the competencies in terms of knowledge skills and values themselves. This is why some frameworks such as the Rounder Sense of Purpose (RSP) are adopted in teacher training programs (EU, 2019). It should be noted however that the knowledge and awareness of teachers of ESD is not the core of this study, However, it was important to probe this aspect to complement the findings of the content analysis by the insights of the teachers reflecting on their experience teaching the curriculum at hand from the lens of ESD.

The objective of the interviews was to answer RQ 2: "To what extent are Science teachers teaching this curriculum familiar with and applying ESD Pedagogies?". The interview questions were set according to themes that serve as the reference for the deductive analysis of the interview responses based on the Analytical Framework. According to Clark and Creswell (2014), "Deductive Analysis" is done by the researcher setting a specific purpose to the interview questions posed based on the purpose of the study and the research questions. Deductive themes for the questions are based on the Analytical framework of this study; the knowledge, skills, and values of ESD that teachers need to have, (Figure 3.3.). The themes of the questions are:1) The experience of teachers using the teacher's guide of the Techbook provided by the Egyptian MOETE, 2) The Professional development the teachers received specifically for teaching that new curriculum, 3) Knowledge and Awareness of the teachers of "SDGS" and "ESD", 4) Teachers opinions of the

top three skills students should acquire through Science education, and 5) The main strengths and challenges that teachers face teaching this curriculum.

The inquiry about the methodologies used for teaching was general with no explicit reference to ESD pedagogies in the interview questions, however, the analysis considers the ESD pedagogies used even if the teacher reported a lack of knowledge of ESD as a concept. “The Value” chosen in that framework that teachers should have is “Self-Efficacy” as explained in the literature review section (2.6), where the motivation of the teachers to apply the ESD pedagogies is grounded in the Self Determination Theory, serving as the Theoretical Framework of the study related to teachers’ application.

Professional Development is placed as an individual theme on its own to indicate its presence as a cross-cutting theme across the three attributes of ESD for Teachers (Knowledge, Skills, and Values). The questions related to this theme were directly inquiring about general professional development and curriculum–specific ones, and the teachers’ insights on its impact on their teaching. The questions’ formulations and phrasing for the three groups of participants are slightly different relating to the different context groups. The three interview questions documents; Teachers’ Interviews, Curriculum Experts and Developers Interviews, and the former MOETE, Dr. Tarek Shawki, are all attached in (Appendix B).

3.3.2 Data Collection Tools

The three data collection tools of the research design are explained in the following sub-section. These tools are Document Analysis, Content Analysis, and Interviews.

3.3.2.1 Document Analysis

Document analysis involves a systematic procedure for reviewing or evaluating various types of documents, including printed and electronic materials (Bowen, 2009, p.27). According to Bowen (2009), this qualitative research method entails examining data to elicit meaning, gain understanding, and develop empirical knowledge. Qualitative document analysis, as described by Morgan (2022), can be conducted at

the descriptive level, focusing on extracting explicit meanings from the data. Descriptive qualitative document analysis serves as the initial step in this study's methodology. The primary goal of the document analysis is to investigate the integration of ESD Competencies within a newly developed curriculum under the EDU 2.0 project. On that premise, the questions sought to be answered through the descriptive analysis are based on the Analytical framework of the study.

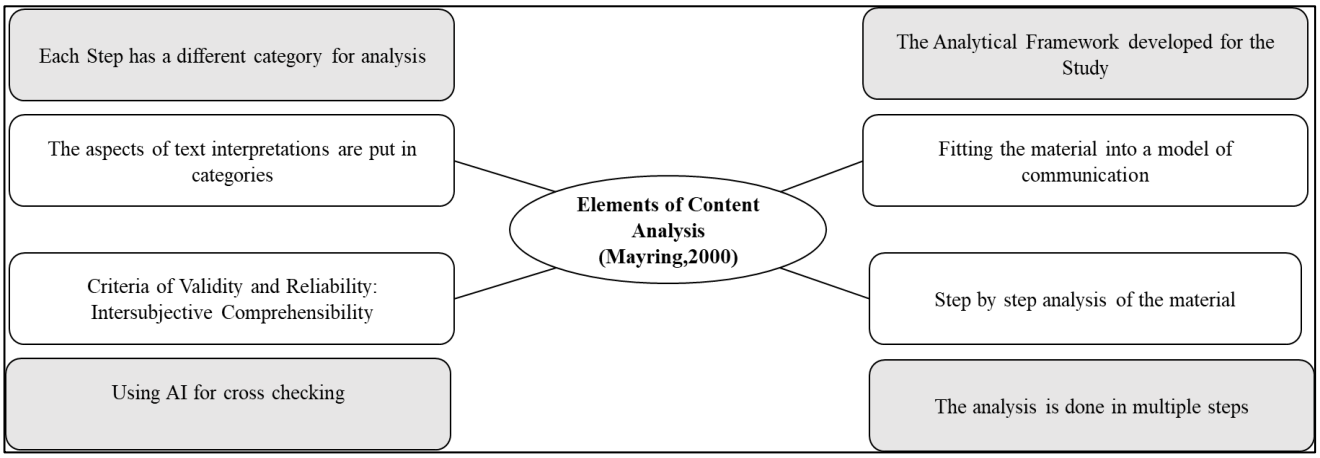
3.3.2.2 Content Analysis

To be able to map the different content materials of the curriculum to SDGs, and their K/S/V strands as well as the 8 ESD Competencies as per the Analytical Framework of the study (figure 3.2), Content Analysis is the adopted tool for this purpose. "*Content analysis is a family of systematic, rule-guided techniques used to analyze the informational contents of textual data"* (Mayring, 2000, p.1.). The notion of inference is especially important in content analysis. The researcher uses analytical constructs, or rules of inference, to move from the text to the answers to the research questions. A content analysis should ideally include four basic ideas. These four basic ideas are explained in Figure (3.10), where the gray boxes show how these elements are applied in the study. According to Mayring(2000), the first element is fitting the material into a model of communication, where it should be determined on what part of the communication inferences shall be made. This is achieved through communicating the inferences to the categories of the analytical framework developed for the study. The second element is breaking down the analysis into multiple steps and doing the analysis step by step. This is fulfilled in the study as the content analysis is done in three steps. The third element is putting categories for the text interpretation based on the research questions. This is applied in the study where each step of the analysis sought to analyze content based on a category from the analytical framework. Differentiated levels of the content from the Science Techbook are used in different steps with different rubrics to align with the objectives of each analytical step. The differentiated levels of the content are used, these are Themes and Concepts for the preliminary mapping of the 17 SDGs, Learning Indicators for mapping the K/S/V/ of each SDG present in the concepts form the

preliminary mapping, and Learning Activities for mapping the 8 key ESD Competencies. For example Step One analyzed the presence of SDGs across the concepts and the Learning Indicators, where the category is the “Knowledge” of SDGs. Step Three analyzes a different type of content (the learning activities), where the category from the framework is the eight ESD competencies. The fourth and final element is the criteria of credibility and reliability, where intersubjective comprehensibility should be achieved. The application of this element is the study is deficient and is considered a limitation, as cross- checking with a subject expert was not feasible. In attempting to overcome this limitation with the growing interest and influence of Artificial Intelligence (AI) in the context of Education and Research, I employed three different AI tools for cross-checking. Poe, Gemini, and Chat GPT 3.5. The criterion for acceptance was achieving an aligned mapping choice consistent with the one I had already established before generating the AI response. For example, when mapping the Learning Indicators to SDGs, the same prompt is given to the 3 AI tools “What SDG/s can be referred to in the phrasing of this learning indicator “Advocate for how to maintain the health and safety of the air living organisms rely on for life.”

Figure 3.10

The Four Elements of Content Analysis (Mayring,2000) and their application in the study

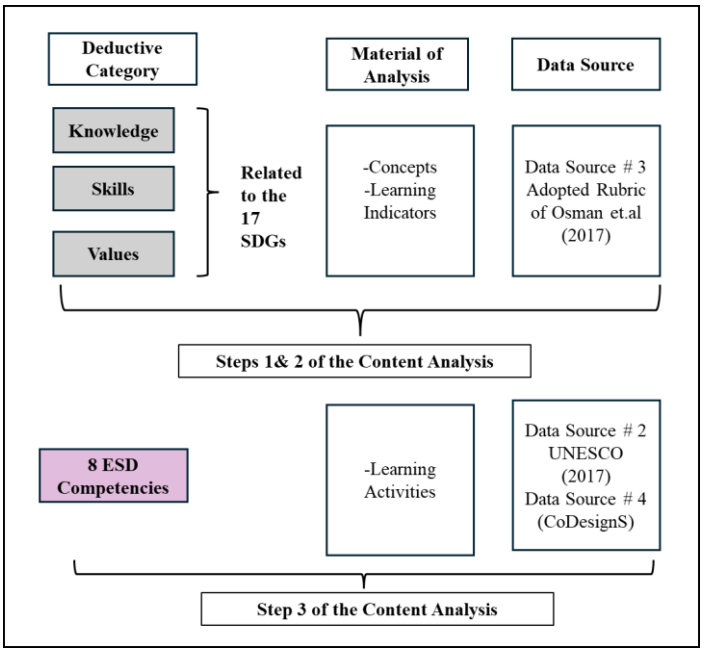


The outcome of the content analysis is descriptive aligning with qualitative Content Analysis methodologies, however, data presentation in values is used for an added layer of precision to the description.

To answer the first RQ “To what extent does the newly developed Science Curriculum of Primary four integrate ESD Competencies?” On the basis of the Analytical Framework, three steps of content analysis were conducted to cover all the categories in the framework. The formulation of the steps based on the categories is shown in figure (3.11) Rubrics were developed for each of the three steps in the analysis process. Each rubric incorporates a deductive category derived from the Analytical Framework, along with the corresponding content extracted from the techbook designated for the analysis. The deductive categories are the Knowledge, Skills, and Values (K/S/V) of the SDG and the eight key ESD Competencies outlined in the UNESCO ESD Learning Objectives (2017).

Figure 3.11

The Relationship between the Deductive Categories, the Steps of the Analysis, and the Data Sources



The techbook which is Data Source #1, is comprehensively described in the Data Sources section (3.3.1) It encompasses four overarching themes, each of which is further subdivided into 3-4 concepts. These concepts, in turn, consist of a collection of Learning Indicators (LIs) and Learning Activities (LAs).

The table offers a concise summary of the three steps involved in the content analysis process, outlining the deductive categories used, the corresponding content analyzed, and the respective Data Sources utilized for each step.

Table 3.1

Summary of the Steps of the Content Analysis

Step of Content Analysis	**Objective**	**Outcome**	**Deductive Category**	**Material to be Analyzed**	**Data Source/s Used for the Rubric**
Step 1	To map the concepts Learning Indicators across the curriculum to the 17 SDGS	The SDGs and their dimensions distribution across the concepts of the curriculum	Knowledge of SDGs	Concepts of the four themes in terms 1 and 2 And the Learning Indicators	Data Source # 2
Step 2	To map the learning indicators of the concepts to the knowledge, skills and values of the mapped SDGs in step 1	The K/S/V per SDG in each LI	K/S/V	Learning Indicators of each concept	Data Source # 3
Step 3	To map the learning activities to the 8 ESD Key Competencies	The presence of each of the 8 competencies in each Learning Activity	The 8 ESD Key Competencies	Learning Activities of each concept	Data Source # 2 and # 4

In the first step of the content analysis, the main objective was to map the presence of the SDGs across the curriculum to know which SDGs are present and which are not. The themes and the concepts are

first analyzed in the first round of screening to map the main titles of the concepts to their respective SDGs. Figure x shows the template for this screening step. A second round of screening is done for the Learning Indicators (LIs) as LIs are a more detailed layer of content for analysis to map to the SDGs, where the titles of the concepts alone do not give much detail, but rather reflect the main idea (the Concept Title) and its relevance to the SDGs. This step is considered foundational for step 2 when the Learning Indicators are analyzed per SDG. Therefore, the category of the analysis is the 17 SDGs, and the content analyzed is LIs. The rubric template sample is shown in Figure (3.12). The rubrics for this step along with the rubrics templates of all steps are attached as Appendix C.

Figure 3.12.

A Snapshot of the Rubric Developed for Step 1 of the Content Analysis

Unit (Theme)	Concept	Related SDG	Environmental	Social	Economic
1- Living Systems	1.1. Adaptation and Survival	15- Life on Land	x		
	1.2. Senses at Work	15- Life on Land	x		
	1.3. Communication and Information Transfer	15- Life on Land	x		
2- Motion	2.1. Starting and Stopping	15- Life on Land	x		

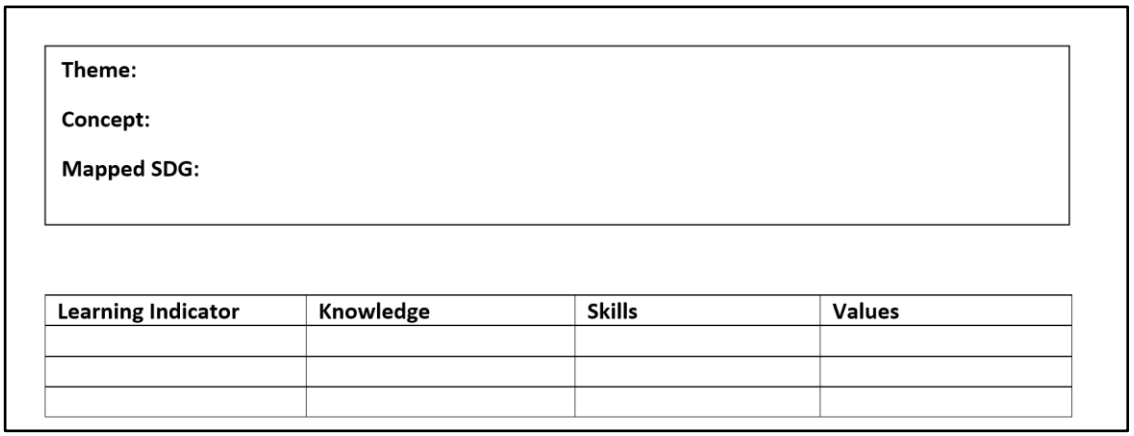
In the second step of the content analysis, the objective was to relate the Learning Indicators (LIs) to the three strands of K/S/V. The main source utilized for developing the rubric for this step is Data Source # 3, the Curriculum Framework of the SDGs by Osman et al. (2017). As indicated in the Data Sources section, the framework provides a structured approach to aligning learning objectives with the knowledge, skills, and values of the SDGs. The choice of the LIs rather than objectives was due to the inaccurate phrasing of the learning objectives in the Techbook. The Arabic version of the techbook was also investigated to be considered for translation to English to use what is labeled as the “Learning Objective”

stated in the book, however, there was no difference. Hence, the LIs were chosen as the material content for the purpose of this analysis step using the rubric developed.

The learning indicators of the entire curriculum are displayed in the teachers' guide version in the introduction section of the techbook. The indicators are listed under the title “Scope and Sequence”. There are six Disciplinary Domains under which the indicators are listed: 1) Skills and Processes, 2) Earth and Space Science, 3) Life Science, 4) Physical Science, 5) Environmental Science, and 6) Engineering Design and Process. Under each Disciplinary Domain, the learning indicators and their sub-indicators are listed. The guide includes the presence of the learning indicators of the themes of Primary four in the preceding grade levels; Primary one, two and three for showing the vertical alignment and the prerequisite knowledge of the students on the theme. At the beginning of each concept, the learning indicators specific to the concept are displayed in the teachers’ guide version. This is the material content that is used in this step of the analysis. Figure (3.13) shows the template of the rubric, and it is attached with the other rubric templates as Appendix C.

Figure 3.13

A Snapshot of the Rubric Developed for Step 2 of the Content Analysis



Theme:

Concept:

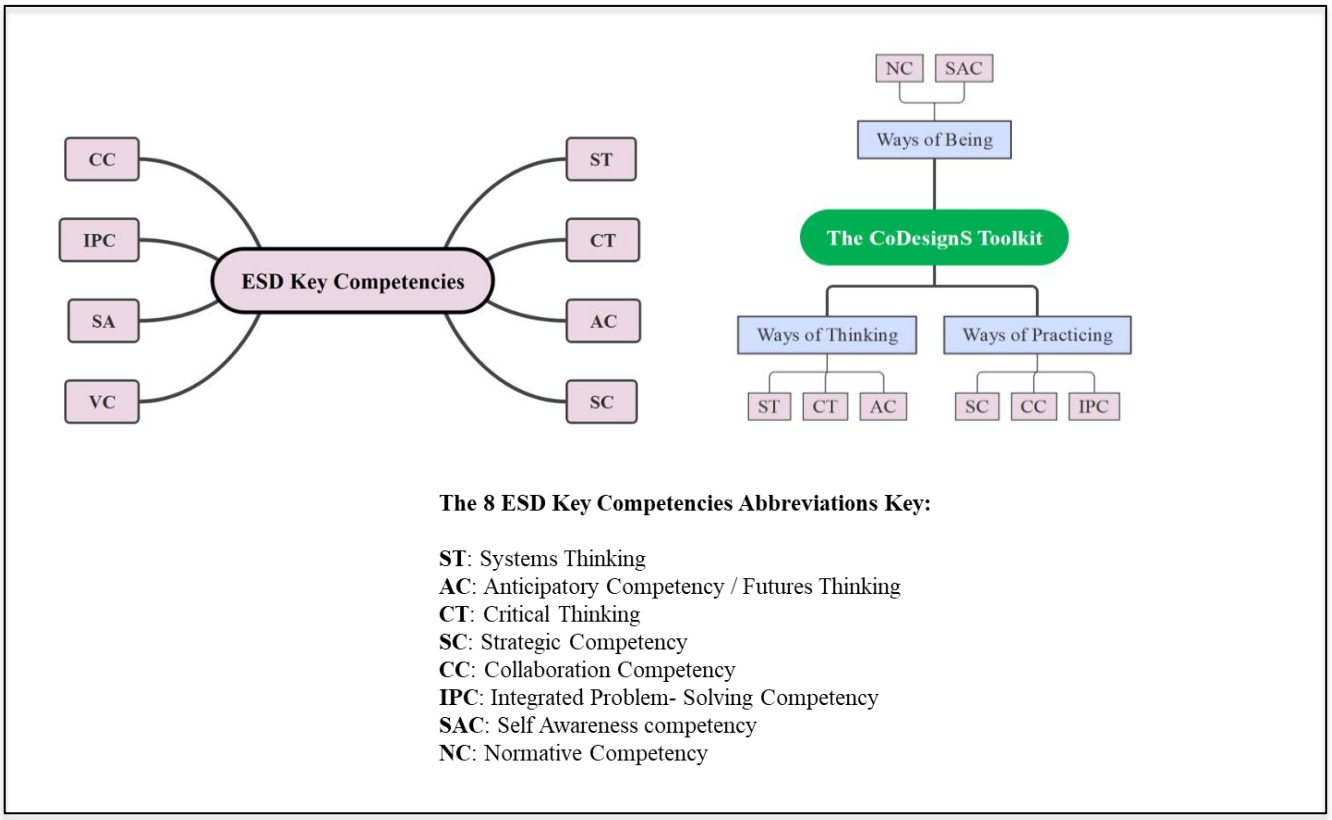
Mapped SDG:

Learning Indicator	Knowledge	Skills	Values

The third and the final step of the content analysis is the mapping of the Learning Activities (LAs) to the eight ESD Competencies. The content material used for the analysis in this step is the Learning Activities and the deductive category of analysis is the eight ESD Key Competencies of the UNESCO ESD Learning Objectives (2017) . The CodesignS Toolkit (Data Source # 4) is used in the development of this rubric as well, as it adds a layer of categorization that provides more specificity for the 8 ESD Competencies and hence allows for more accurate mapping. The added layer is “Ways of Thinking”, “Ways of Practicing” and “Ways of Being” as shown in figure 3.14. The reason for the choice of Learning activities is that the prompts of the activities give a relatively sufficient text for inferring the most accurate corresponding ESD Key Competency if present. Also, the activities are described for teachers in three subtitles: “Purpose”, “The Strategy” and “The Instructional Focus”. This gives a comprehensive description of the activity. In addition to that, some activities are tagged with one of the skills that are considered for the curriculum framework set by the MOETE as described in the Document Analysis findings. This further validates the mapping of competencies when the competency mapped to the activity is aligned with the skill that is linked to the activity in the curriculum.

Figure 3.14

Categorization of ESD Competencies



The rubric template is shown in Figure 3.15 and the rubric is attached with the other rubrics as Appendix C

Figure 3.15

A Snapshot of the Rubric developed for Step 3 of the Content Analysis

Unit 1: Living Systems

Concept 1.1: Adaptation and Survival

Main SDG: 15 – Life on Land

Learning Activity Code	Skills						Values	
	Ways of Thinking			Ways of Practicing				
	ST	CT	AT	SC	CC	IPS	SAC	NC
U1.C.1.1.A.1								

3.3.2.3. Interviews

This data collection tool seeks to answer RQ 2 “To what extent are Science Teachers teaching this curriculum familiar with and applying ESD Pedagogies?”.

Purposeful Sampling was followed for recruiting the participants explained in the Participants Section (3.2). The interviews were semi-structured one-to-one interviews that were dialogic and interactive, and that were audio and video-recorded, conducted online via Zoom, except for the interview with the former MOETE, Dr. Tarek Shawki, which was conducted face to face and was audio-recorded. The average duration of each interview was around forty-five minutes. All responses are confidential except for the responses of Dr. Tarek Shawki. Ethical issues were considered where all participants signed a consent form for participation. Confidentiality is achieved by the researcher being the only person having access to the recordings as well as the coding keys for the participants.

3.4. Data Analysis

3.4.1 Document Analysis

The central question to be addressed through this qualitative description is the research question (RQ), "To what extent does the newly developed Science curriculum design of Primary Four integrate ESD Competencies?" This question is answered by inferring and describing the presence and depth of ESD Competencies within the curriculum based on the themes set according to the Analytical Framework. The themes are: main objectives, publication context, authorship and development involvement, philosophical underpinnings, approach, teacher support tools, and organizational structure. The three main themes are the presence of SDGs and ESD through the context of developing the curriculum, its main objectives, philosophy, and approaches.

The techbook was thoroughly reviewed in rounds, each targeting the description to cover the themes of interest. The first round of review was to look into the introduction of the techbook that explains the context, the objectives, the philosophy, and the approach. The second round of review was for the main titles of the concepts and their breakdown, the flow, and the pacing of the learning activities. The final round was through reviewing the parts of the guide that are considered tools and resources that support teachers, inferring the extent of their alignment with ESD concepts and pedagogies.

3.4.2. Content Analysis

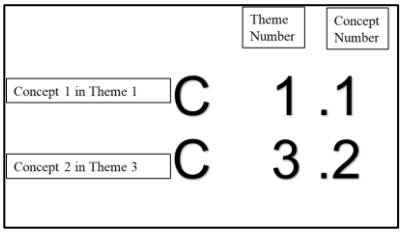
For the analysis of content material across the three steps, the content was extracted from the Techbook, and coding was applied to facilitate the analysis process. The rubric templates were then adapted to Microsoft Excel sheets to enhance the ease of analysis and presentation of findings. The core of the analysis primarily aligns with a qualitative and descriptive approach, as elaborated in the Data Collection section 3.3.2.1 However, the data were also subjected to frequency analysis to pinpoint occurrences, which were subsequently presented as percentages in the findings. This provision of values shows the weight of

the SDGs present across the curriculum, their corresponding Knowledge, Skills, and Values (K/S/V), as well as the prominence of the ESD Competencies.

In Step 1, the initial mapping of the Sustainable Development Goals (SDGs) to the concepts is undertaken. These concepts serve as the primary headings for the topics, thereby considering the SDGs mapped as the primary SDGs corresponding to the main headings. A total of 13 concepts are distributed across the four thematic areas. Each concept is assigned a code, which is utilized in the rubric, as depicted in Figure (3.16).

Figure 3.16

The Code Key for Concepts of the Techbook



Furthermore, within the same step, a secondary screening for SDGs is conducted for the learning indicators, providing a deeper level of analysis by deconstructing the concepts into more layers of their components for a more thorough analysis. The learning indicators are presented in the introductory section of the Techbook Teachers' Guide version and are categorized into six Disciplinary Domains. For the purpose of analysis, only subject-specific learning indicators are utilized, specifically those related to Life Science, Physical Science, Earth and Space Science, and Environmental Science. The remaining two Disciplinary Domains (Skills and Processes, and Engineering and Design Processes) are excluded from the analysis due to their lack of linkages to any SDG. These LIs are then redistributed in the curriculum at the beginning of each concept, where only the LIs relevant to the concepts are placed with their codes. The analysis is done for the collective LIs per disciplinary domain, hence the weight of occurrence for the LI

across the curriculum is not considered in this qualitative analysis. A total of 11 LIs are analyzed. The analysis of this step can be accessed through this link.

The findings of step 1 are foundational to the analysis in step 2. The 11 mapped SDGs to the LIs in Step 1 are the ones used to develop separate rubrics for each of the mapped SDGs for the analysis in Step 2 where the deductive categories are the K/S/V of the SDG. This approach facilitates the usage of the UN Curriculum Framework by Osman et.al (2017), Data source # 3 was used for the analysis of step 2, as the rubric is structured to encompass the 3 strands K/S/V per SDG for the 17 SDGs. A sample of the analysis for SDG 3 is shown in Figure (3.17).

Figure 3.17

A Snapshot of Mapping the LIs with the K/S/V of SDG 13

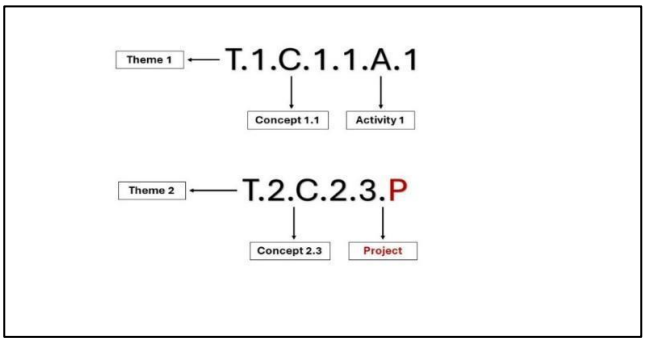
Learning Indicator	Strands from the UN Curriculum Framework	Knowledge	Skills	Values
b. Propose ways to maintain the health and safety of the digestive system. 1) Relate the organs involved in digestion to their function in the digestive system. 2) Explain how the organs in the digestive system work together to break down and absorb food for energy. 3) Identify potential sources of damage related to the digestive system.	K. 1 Learning to address personal and food hygiene and sanitation, and disease and infection transmission/control K.2.Understanding healthy eating and nutrition S.1.Application of understanding to real life, such as personal hygiene and sanitation, and healthy living (e.g. food choices and exercise)	2	1	
c. Advocate for how to maintain the health and safety of the air living organisms rely on for life (for example, design a public message or advertising campaign). 1) Relate the organs involved in breathing to their function in the respiratory system for multiple species (such as humans and fish). 2) Identify threats to healthy respiration (such as smoking or causes of air and water pollution).	K.5.Learning about pressures and harmful behaviors, and ways to resist themS.1.Application of understanding to real life, such as personal hygiene and sanitation, and healthy living (e.g. food choices and exercise) S.2.Ability to communicate healthy living practices to family and community S.4.Ability to identify positive and negative influences, analyses risks, and make informed decisions V.1.Responsibility for personal health and well-being, placing value on personal hygiene and sanitation, good nutrition, physical activity, and reducing risks to physical and mental health	1	2	

In the third and final step of the analysis, the Learning Activities are analyzed for the presence of the 8 key ESD Competencies. Each LA is presented in the Techbook with the “Purpose”, "Instructional Focus”, "Strategy" and “Skills”. Each concept has an average of 13 – 16 LAs. The Unit Project is the activity in the last concept of the theme. Unit Projects are considered in the analysis too. Interdisciplinary Projects, where there is an explicit mention of SDGs and are focused on solving a real-world challenge, are also considered

for the analysis. There are 2 Interdisciplinary projects, one per term. The coding of the different LA is shown in Figure (3.18). A total of 167 LAs were analyzed for 13 concepts. Activities that were only provided digitally were excluded from the analysis and are considered optional activities in the curriculum. The analysis of this step can be accessed through this link.

Figure 3.18

Code Key for Learning Activities



To conduct the analysis, the operational definitions of the 8 key ESD competencies are reviewed. According to the UNESCO ESD Learning Objectives (2017), the operational definitions are defined as follows:

- Systems thinking competency: the abilities to recognize and understand relationships; to analyze complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.
- Anticipatory competency: the abilities to understand and evaluate multiple futures – possible, probable, and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
- Normative competency: the abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.

- Strategic competency: the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
- Collaboration competency: the abilities to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy); to understand, relate to, and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem-solving.
- Critical thinking competency: the ability to question norms, practices, and opinions; to reflect on one's values, perceptions, and actions; and to take a position in the sustainability discourse. Self-awareness competency: the ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
- Integrated problem-solving competency: the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive, and equitable solution options that promote sustainable development, integrating the above-mentioned competencies.(UNESCO , 2017,p.10).

3.4.3. Interviews

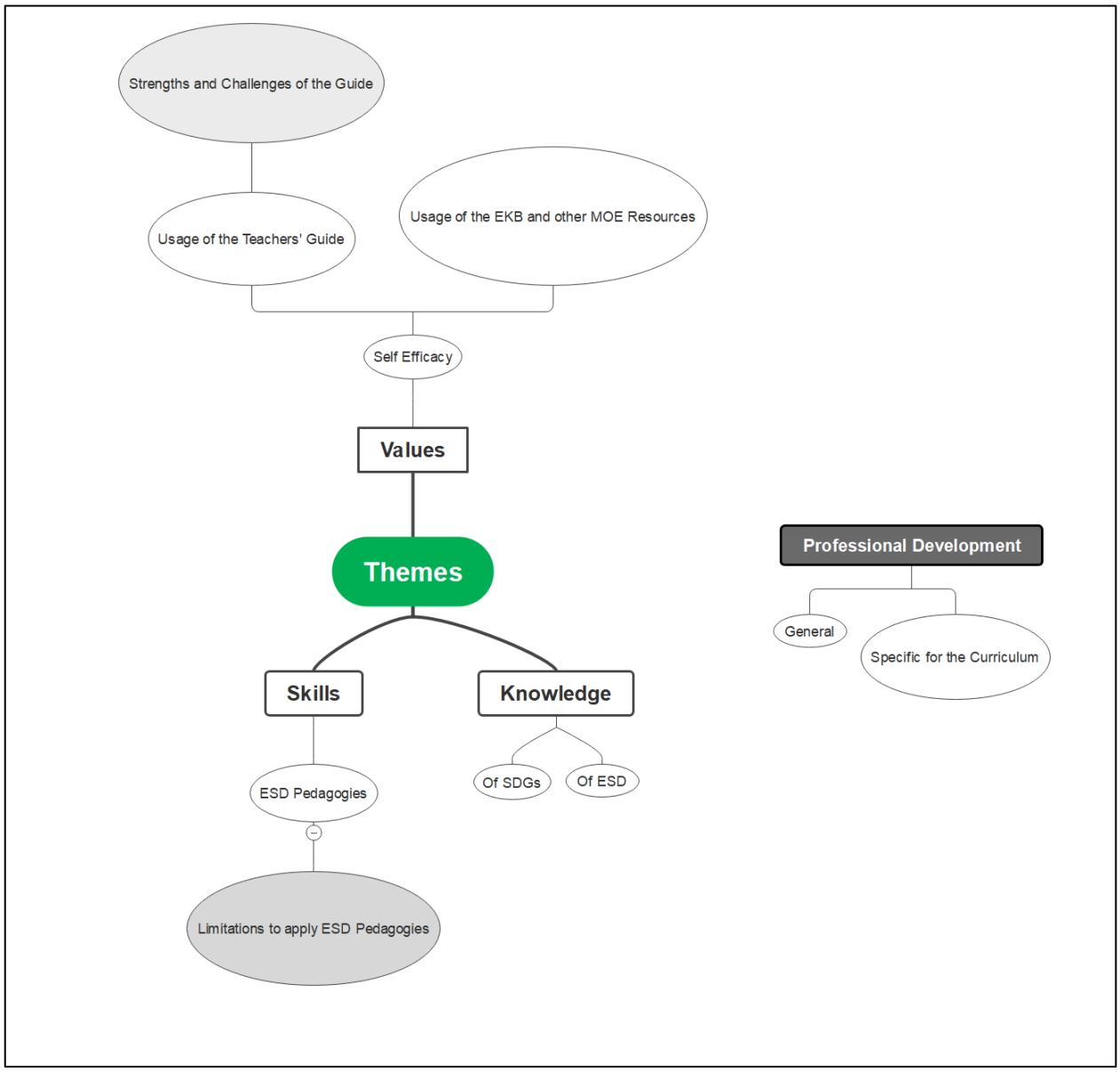
As explained in the Data Collection section (3.3.2.3), the Themes of the Interview questions were based on the Analytical framework of the study, the K/S/V/ of ESD, and the Eight ESD Key Competencies. That was the basis of the thematic analysis of the Interview responses as well. Data analysis of interviews is done through thematic analysis of the interviews after being transcribed and coded. The thematic analysis is inductive and deductive to cover as much as possible from the interviewee's insights (Clark & Creswell, 2014).

According to Clark and Creswell (2014), "Deductive Analysis" is done by the researcher setting a specific purpose to the interview questions posed based on the purpose of the study and the research

questions, while “Inductive Analysis” is dynamic and interpretive, where themes emerge from the data collection. Deductive Analysis is based on the Analytical framework of this study; the knowledge, skills, and values of ESD that teachers need to have. Therefore, the themes of the questions were based on the same framework. However, new themes have emerged while doing the interviews (inductive categories). The themes of the analysis are all shown in Figure (3.19). The white boxes are the themes of the deductive category, while the light gray ones are the inductive category. “Professional Development” is a stand-alone theme as it is overarching the different themes and is linked to both the deductive and the inductive categories.

Figure 3.19

Deductive and Inductive Themes of Interviews Analysis



For data analysis of the Teachers' Interviews, participants were given codes to be used in the presentation of findings in the form of numbers from "01" to "08". The two Curriculum Experts were given the codes "CE. A" and "CE.B" Only the researcher has access to these codes. The themes of the analysis for the teacher interviews are divided into deductive themes, these are:1) knowledge of SDGs and ESD, 2)

ESD Pedagogies, 3) Usage of the Techbook and the EKB resources and 4) Professional Development Inductive themes are: 1) Limitations related to the curriculum structure and design and 2) Limitations related to the practice delivering the curriculum.

The themes for the CE Interviews follow the Analytical framework, however, only the themes that are related to their context are considered, thus the themes are:1) The Curriculum Design and 2) The Professional Development Design

Finally, the analysis of the interview with Dr. Tarek Shawki the leader of EDU 2.0 did not strictly follow the analytical framework, however, the insights were valuable in terms of exploring further from a management perspective the phases of development, planning, and application of the project, thus the themes of the findings are 1) Insights related to the curriculum,2) Insights related to the teachers 3) Insights related to the challenges of application and ways of development.

3.5. Trustworthiness

Elements of Trustworthiness including Triangulation, Validity and Reliability, and Ethical Considerations as well as the limitations in the study are discussed in this section.

3.5.1 Triangulation

According to Clark and Creswell (2014), Triangulating information in qualitative research requires different data sources and different groups of participants to increase the validity of the study. Triangulation is achieved in this study by adopting three different methods of data collection; the Document Analysis, the Content Analysis, and finally the interviews. The Interviews with Curriculum experts and developers and the former Egyptian Minister of Education of Egypt, Dr Tarek Shawki, complement the findings of the document analysis. Having different groups of participants also enhances the triangulation. The Content Analysis findings are complemented by the interviews with Science Teachers. Also, three different data sources were used for the development of the rubrics of the content analysis.

3.5.2 Validity and Reliability

Cross-checking with a co-researcher or a subject expert was not feasible to apply, however, I used three different AI Tools for cross-checking during the content analysis. The criteria I set for the decision-making was aligning two responses out of the three with my mapping choices.

3.5.3. Ethical Considerations

The key principle that should guide researchers in their studies is that concern for the welfare of their participants is crucial (Clark & Creswell, 2014). Research ethics were considered in this study. The researcher took the approval to conduct research and recruit participants related to the organization through the Institutional Review Board (IRB) of the American University in Cairo (AUC). The IRB approval letter is attached as Appendix D. All participants signed a consent form agreeing to participate in the study. The interview procedures were explained to the participants before the interview. There was no harm or benefit to any of the participants in the study. Participants had the right to withdraw from the study with no penalties at any point during the interview.

The responses of the participants are kept confidential, with the researcher being the only subject having access to the recorded interviews.

3.5.4 Limitations of the Study

It should be noted that the insights and reflections provided by one researcher may contain subjective elements, cross-checking with a subject expert is recommended, but that was not feasible. Furthermore, the analysis focuses solely on one curriculum, neglecting to consider its vertical alignment with previously taught and subsequent curricula, which could be foundational providing a more thorough analysis. The sample size of the recruited teachers was limited to eight due to the restrictive criteria of recruitment, where I had to choose student teachers at the PED Program at the AUC, who had to be Science teachers, teaching this specific curriculum. A larger sample size might have generated more insights

Furthermore, there's a suggestion to map learning activities to the Knowledge, Skills, and Values (K/S/V) of SDGs, although this poses challenges due to the need to map learning indicators to activities, which is not done in the techbook. Finally, assessments were only tackled through the interviews but were considered in the Document and Content Analysis within the study's scope due to constraints, but it's recommended to align assessment analysis with the findings of other content materials analyzed.

Chapter 4: Findings

The raw findings as a result of the data analysis of the three data collection tools of the research design are presented in this chapter, followed by a summary of the findings. The critical analysis and reflection of these findings are presented in Chapter Five, Discussion and Conclusion.

4.1. Document Analysis Findings

The themes of the findings of the document analysis are 1) The presence of ESD within the context of development and 2) Teachers' support to adopt ESD pedagogies from a curriculum design perspective.

4.1.1 Presence of ESD in the Curriculum

4.1.1.1 Context of Curriculum Development

This curriculum first launched in the academic year 2021/2022, under the project Edu 2.0 of the MOETE of Egypt. This project is the development of the education sector under the Agenda of Egypt 2030, based on the participation of Egypt in the UN 2030 Sustainable Development Goals that was signed in 2015, among 192 other countries. Thus, the context of development is primarily based on the notion of the curriculum being a tool to achieve SDGs and align with Egypt Vision 2030.

4.1.1.2. Curriculum Philosophy and Approach

The essence of ESD is very clear in the description of this section in the introduction of the Teachers' Guide of the Techbook. The main objective of the curriculum is stated in the introductory section

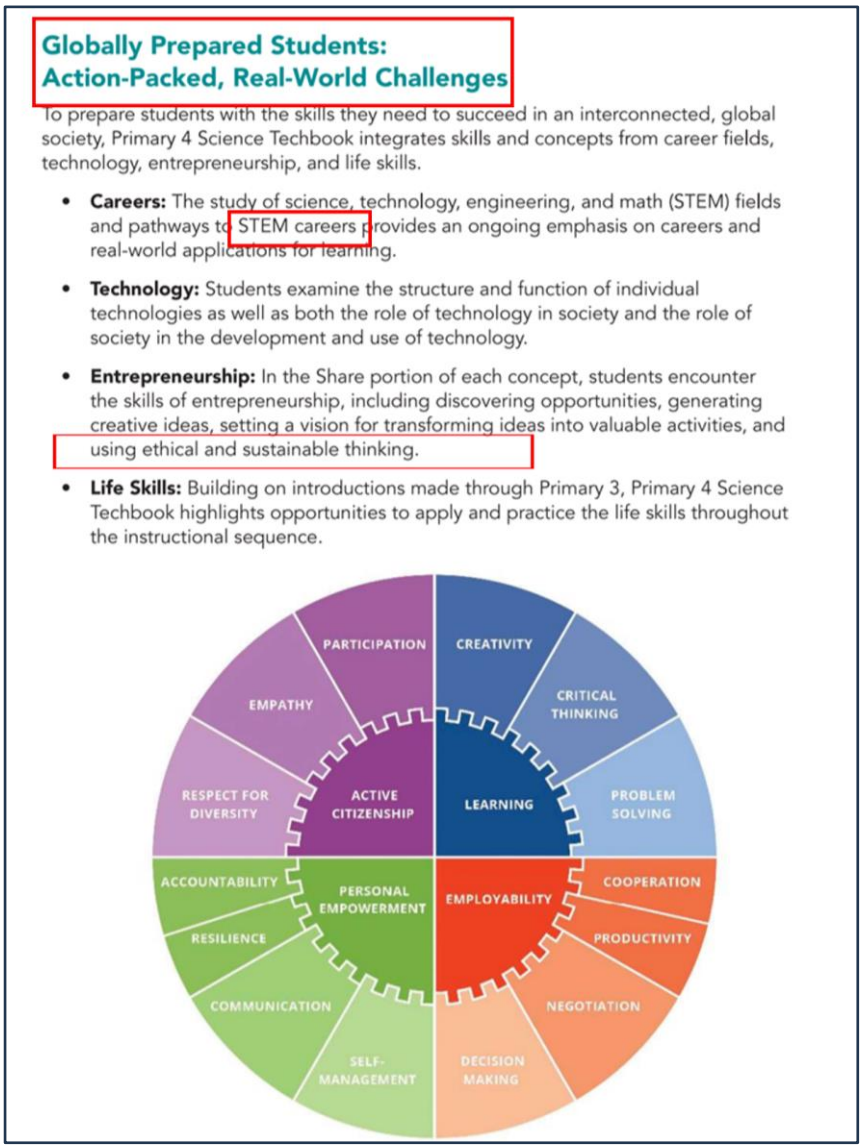
of the Techbook in the "Words from the Minister of Education and Technical Education" which read: " *It is my great pleasure to celebrate this extraordinary moment in the history of Egypt where we continue to launch a new education system designed to prepare a new Egyptian citizen proud of his Egyptian, Arab and African roots — a new citizen who is innovative, a critical thinker, able to understand and accept differences, competent in knowledge and life skills, able to learn for life and able to compete globally."* (Egyptian MOETE & Discovery Education, 2022, p.4). The usage of keywords that align with the understanding of ESD Competencies is evident in this quote, referring to the combination of knowledge, life skills, and values – presented in "understanding and accepting differences"- and the reference to "learning for life and competing globally" implies the consideration of utilization of learning in life applications, including solving challenges including the global context.

The program philosophy is based on three-Dimensional Learning which are the Disciplinary Core Ideas, Science Skills and Processes, and Connecting Ideas to other Disciplines. It is explicitly stated in the program philosophy that "The Techbook embodies the shift in EDU 2.0 framework focusing on 1) Students centered Learning, 2) Hands-on Learning and 3) Creating globally prepared students by integrating Career, Technology, Entrepreneurship and Life Skills". These approaches are core ESD approaches. Students Centered learning is manifested in the flow of each Concept, where there are 3 main sections;" Wonder", "Learn" and "Share". The concept starts by sparking the students' curiosity by asking questions, and the "Learn" comprises the activities that help students find answers posed in the " Wonder" section and finally the "Share" section, where the learning is summarized through activities targeting application of the learning and " Providing solutions to Real-world challenges".

The approach of preparing "Globally Prepared Students" specifically aligns with ESD, where it is presented in the activities of the concepts divided into categories of Career, Technology, Entrepreneurship, and Life Skills. Figure (4.1) shows a snapshot and some of the terms and expressions that directly align with ESD.

Figure 4.1

A Snapshot from the Program Philosophy of the Science Techbook



Source: Egyptian Science Techbook, p. 13

The Approach of Learning as explained in the introductory section as well explicitly mentions SDGs in the form of the Interdisciplinary Project that is one of the assessments. There are 2 Interdisciplinary Projects in the curriculum, one per term. It is a graded project where students are given a prompt including an SDG related to the concept. The Interdisciplinary Project of Term one is allocated in Concept 1.4. and is

based on SDG 11. Term two Interdisciplinary Project is allocated in concept 3.3 and is based on SDG 7. Figure(4.2) shows snapshots mentioning the Interdisciplinary Projects in the introduction and the prompts of the projects of term 1. Figure (4.2) shows the Interdisciplinary Project of term two.

Figure 4.2

A Snapshot of the Interdisciplinary Projects in the Science Techbook

Source: Egyptian Science Techbook, p.21

The Science Curriculum design demonstrates a deliberate integration of elements related to Scientific Literacy and the Nature of Science. This integration is particularly evident in the philosophy outlined in the Techbook, which incorporates “Science Skills and Processes" as one of the dimensions within the 3-Dimensional Learning Model. Additionally, the mapping of Learning Indicators across the 6 Disciplinary Domains, presented in the introductory section of the Techbook, illustrates the presence of

Science Skills and Processes across all four themes. Moreover, the inclusion of “Engineering Design and Processes" as another Disciplinary Domain further enriches the curriculum with skills related to inquiry and research, aligning with the objectives of Scientific Literacy and the Nature of Science, which further indicates the integration of ESD competencies as a consequence as discussed in section (2.5.5)

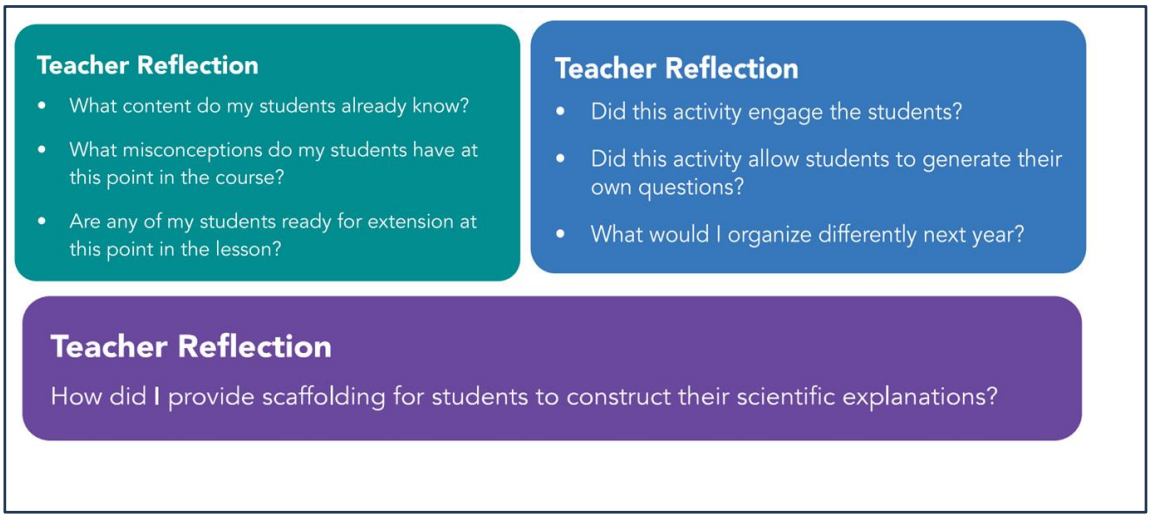
4.1.1.3 Teachers’ Support

The philosophy and the approach of the curriculum as described in the introduction of the techbook are implemented in the form of a series of activities per concept. Providing the teachers with the support to conduct these activities should further encourage them to apply them. The Teacher’s Guide version of the Techbook serves as a manual for teachers to prepare and conduct their lessons. This guide is available as a print version and digitally, through the Learning Management System (LMS) of the MOETE. Other support materials are available such as the resources of the Egyptian Knowledge Bank (EKB). In the Teacher's Guide version, the support for teachers' planning is manifested in the presentation of the concepts. Each concept begins by displaying “a storyline” for the unit, which gives the teacher an overview of the flow of the unit and its intended learning outcomes in a summary. It also gives the teachers at the beginning of the concept ideas for engaging students in the “central phenomenon” of the unit by providing guiding questions for discussions with students. Also, there are suggestions for activities that encourage the student-centered approach, like guides for how students can create a vocab book for the new terms of the unit. The presentation of the content of the concept to teachers is in the form of activities that are “Printable Resources". Each concept contains an average of 14- 16 activities. In addition to the printable resources, optional digital activities are provided. These activities are structured as Purpose, Instructional Focus, and Strategy. Activities that have investigations include the list of materials the teacher needs to prepare or to communicate with the students to be prepared. Ideas of differentiation are provided for many activities. Activities that require students to answer open-ended questions are provided with sample responses for the

teachers as well as "Teacher Reflection" questions, for the teacher to reflect on their teaching. Examples are shown in snapshots from the Techbook in Figure (4.3)

Figure 4.3.

Snapshots of "Teacher Reflection" Guides in the Techbook



While these features are intended to inspire teachers to engage students in curriculum-aligned activities, an investigation into the pacing guide presented at the concepts' introduction revealed a notable shortage of available time to comfortably facilitate all the displayed activities.

4.2. Content Analysis Findings

The Content Analysis is presented as findings of the three main steps:

1) Mapping of the Learning Indicators Per Concept to the Sustainable Development Goals (SDGs).

2) The Mapping of the Learning Indicators (LIs) per SDG to the three strands of Knowledge, Skills, and Values (K/S/V) per SDG.

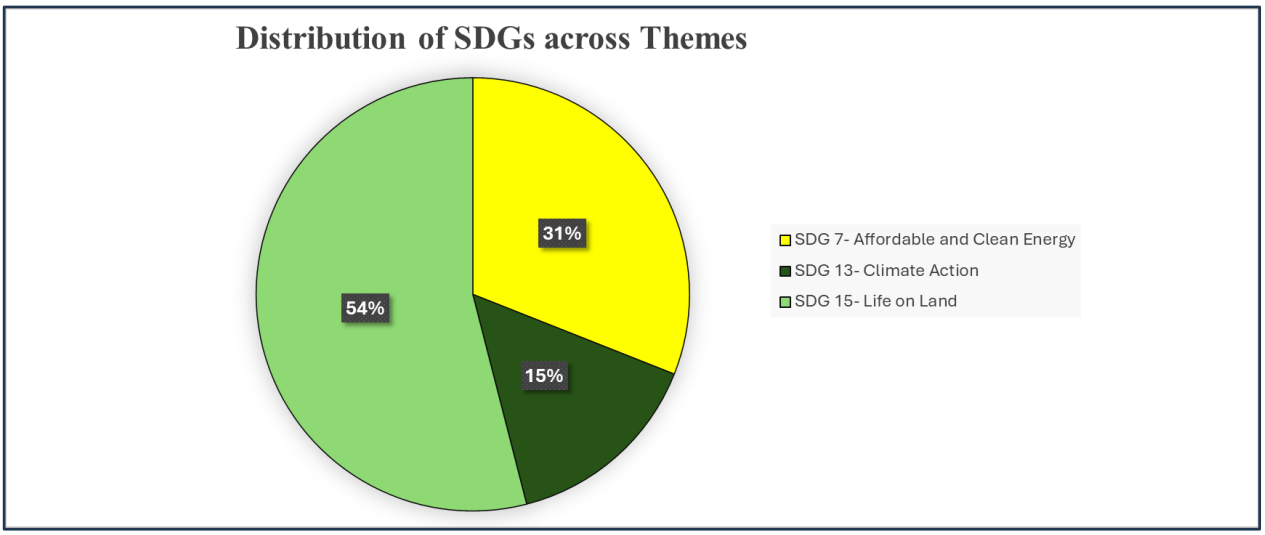
3) The mapping of the Learning Activities (LAs) to the 8 key ESD Competencies of UNESCO (2017).

4.2.1. Step 1- Mapping the Learning Indicators per Concept to the SDGs

Before mapping the Learning Indicators (LIs) of the Concepts to the Sustainable SDGs, the initial step involves mapping the Concepts to the SDGs. Among the SDGs, only SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action), and SDG 15 (Life on Land) represent the main topics or "Themes" of the Curriculum. For instance, Theme 1 "Living Things" addresses the adaptation of living things and ecosystems, while Theme 4 "Shifting Surfaces" covers topics like volcanoes and Earth formation, both mapped to SDG 15 (Life on Land). Theme 3 "Motion" explores types of energy and motion, and Theme 3 "Energy and Fuels" delves into sources of energy and their applications, both mapped to SDG 7 (Affordable and Clean Energy). SDG 13 (Climate Action) is partly mapped to Theme 3 and Theme 4. Figure (4.4) illustrates the mapping of the SDGs to these themes.

Figure 4.4

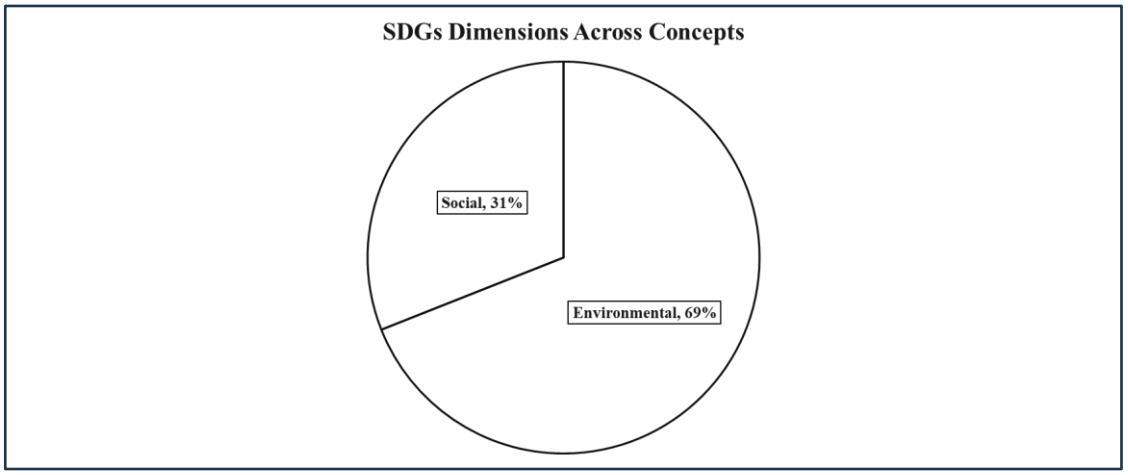
The Distribution of the SDGs across the 4 Themes



The total number of concepts in the four themes is 13. The results of this analysis show that the majority of the concepts are mapped to SDG 15 - Life on Land (54%), followed by SDG 7 - Affordable and Clean Energy (31%), and finally SDG 13 - Climate Action (15%). These results consider only the mapping of the SDGs to the concept titles and descriptions, without considering the Learning Indicators. In terms of the three dimensions of SDGs (Environmental, Social, and Economic), the distribution across the concepts is shown in Figure (4.4).

Figure 4.4

Distribution of SDG Dimensions across Concepts

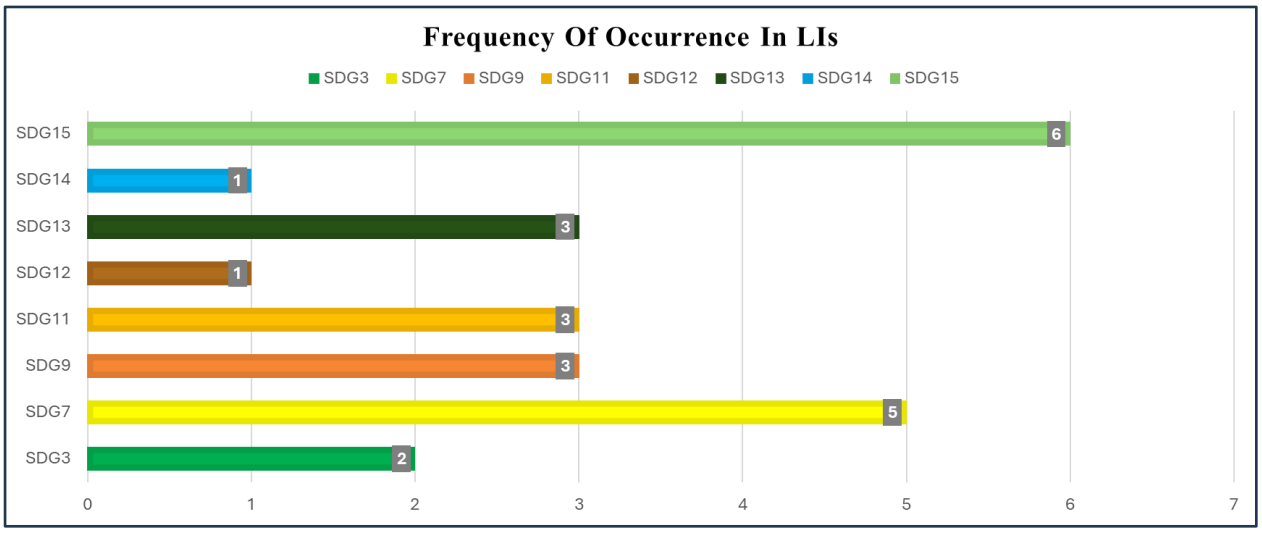


The Economic dimension is not present in the results of this mapping, while the Environmental dimension comprises the highest percentage across concepts (69%), and the Social dimension (31%).

The second layer of mapping for more reflective findings is mapping the SDGs to the Learning Indicators that are distributed across the 13 concepts. Figure 4.5 shows the findings presented as the frequency of occurrence of the mapped SDG to the Learning Indicator across a total of 11 Learning Indicators.

Figure 4.5.

Percentage of each SDG across the Learning Indicators



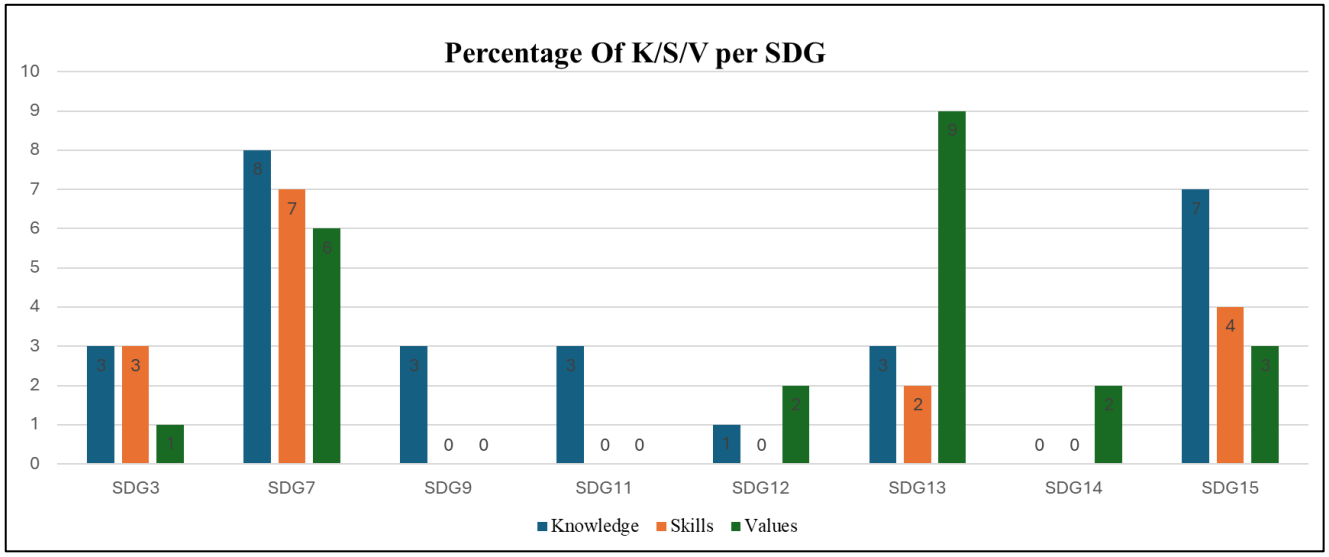
Eight SDGs are relevant to the total of 11 Learning Indicators (LIs) of the curriculum. The findings reveal that the top SDGs mapped across the LIs align with the findings of the mapping to the concepts. SDG 15 has the highest percentage (24%), mapped to 6 LIs of the total 11, followed by SDG 7 (20%), mapped to 5 LIs, and SDG 13 (16%), mapped to 4 LIs. The other SDGs that emerged from the mapping to the LIs were SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities), each with equal shares of the mapped SDGs (12%), each mapped to 3 LIs. This is followed by SDG 3 (Good Health and Well-being) at 8%, mapped to 2 LIs, and finally, SDG 12 (Responsible Consumption and Production) and SDG 14 (Life Below Water), with equal shares of 4% each, mapped to 1 LI each. Only the mapped SDGs from this step are considered in step 2, where each LI is mapped to the Knowledge, Skills, and Values of each of these SDGs.

4.2.2. Step 2- Mapping the Learning Indicators per SDG to the 3 strands of K/S/V

The results of mapping the Learning Indicator per the already mapped SDG from Step 2 are shown in Figure 4.6. Each Learning indicator was analyzed to the strands of Knowledge, Skills, and Values based on the rubric of Osman et.al (2017).

Figure 4.6.

Percentage of K/S/V per SDG



As shown in the figure, the 11 learning indicators related to SDGs 3 (Good Health and Well-being), 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land) were analyzed through the rubrics developed for this step as explained in section x. Among these, SDGs 7, 13, and 15 are found to include the highest percentage of the 3 strands. The highest percentage of knowledge was found to be in the LIs related to SDG 7, followed by SDG 15, aligning with the findings of step 1, showing these 2 SDGs as the ones with the highest weights, also linked to more than half the main topics of the curriculum, and thus having the "Knowledge" strand as the highest aspect. SDG 13 (Climate Action) shows the highest presentation for "Values" in the learning indicators, although its presence as an SDG related to the main

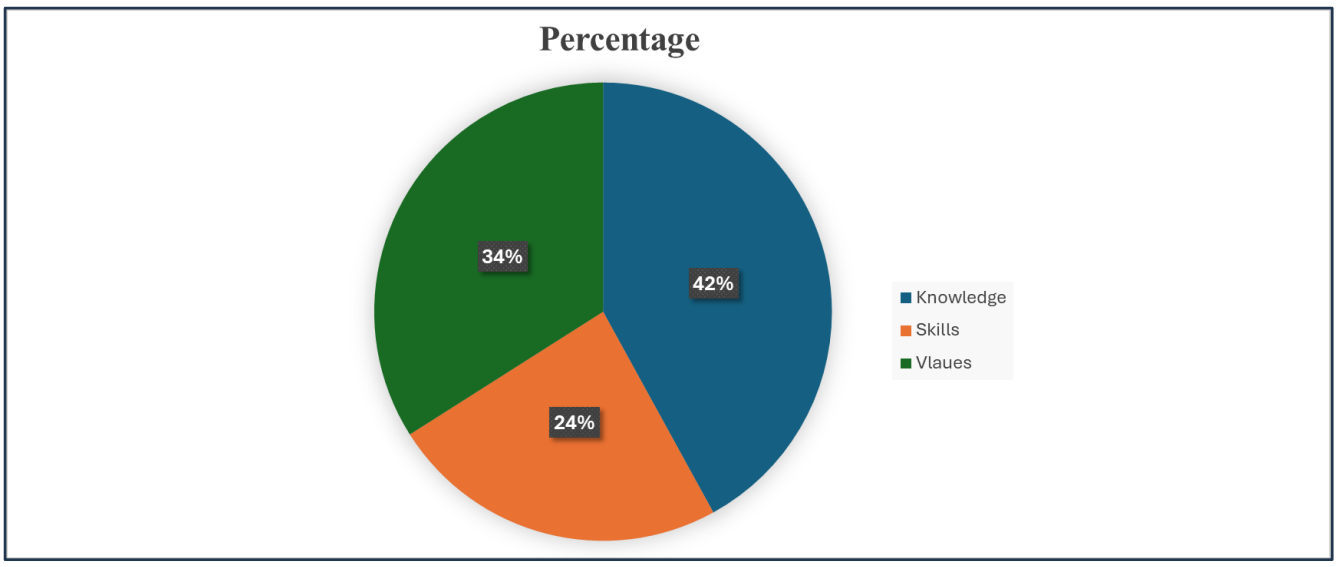
topic was the least presentation in step 1. This finding indicates that the curriculum considers nurturing the values related to Climate Action even though the main topics do not directly tackle this issue, and thus the knowledge strand of SDG 13 is not as high as those of SDGs 7 and 15, mapped to the main topics.

The Skills strand is found to be highest in the 2 main SDGs mapped to the concepts, SDG 7 and SDG 15. The presentation of the "Knowledge" strand and the "Values" strand being the highest in the main SDGs indicates the general direction of the curriculum to be more focused on the knowledge and skills related to the main topics.

The general distribution of the 3 strands across the LIs of the curriculum is presented in Figure (4.7), showing Knowledge being the highest strand at (42%), followed by Values at (34%), and finally Skills at (24%)

Figure 4.7.

Percentage of Total K/S/V in Learning Indicators



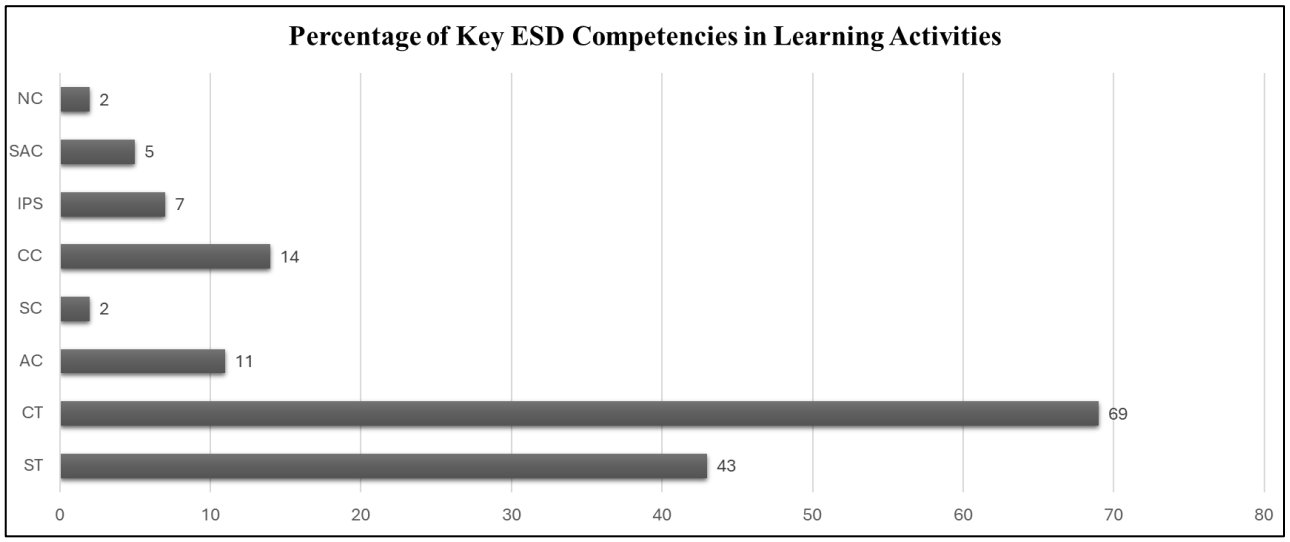
4.2.3. Step 3 – Mapping the Learning Activities to the 8 Key ESD Competencies

The third and final step was mapping the 8 key ESD competencies across the Learning Activities (LA). The eight competencies are the group that comprises the “Ways of Thinking and ways of practicing” according to the CoDesignS 1) Systems Thinking (ST), 2) Critical Thinking (CT), 3) Anticipatory Competency (AC), 4) Collaboration Competency (CC), Integrated Problem Solving (IPS), and Strategic Competency(SC), and finally the 2 competencies grouped under “Ways of Being “; 7)Normative Competency (NC) and 8) Self Awareness Competency (SAC).

The analysis was done for the activities per concept. A total of 167 LAs were analyzed. The findings are presented in Figure (4.8)

Figure 4.8

Percentage of the 8 Key ESD Competencies in the Learning Activities of the 4 Themes



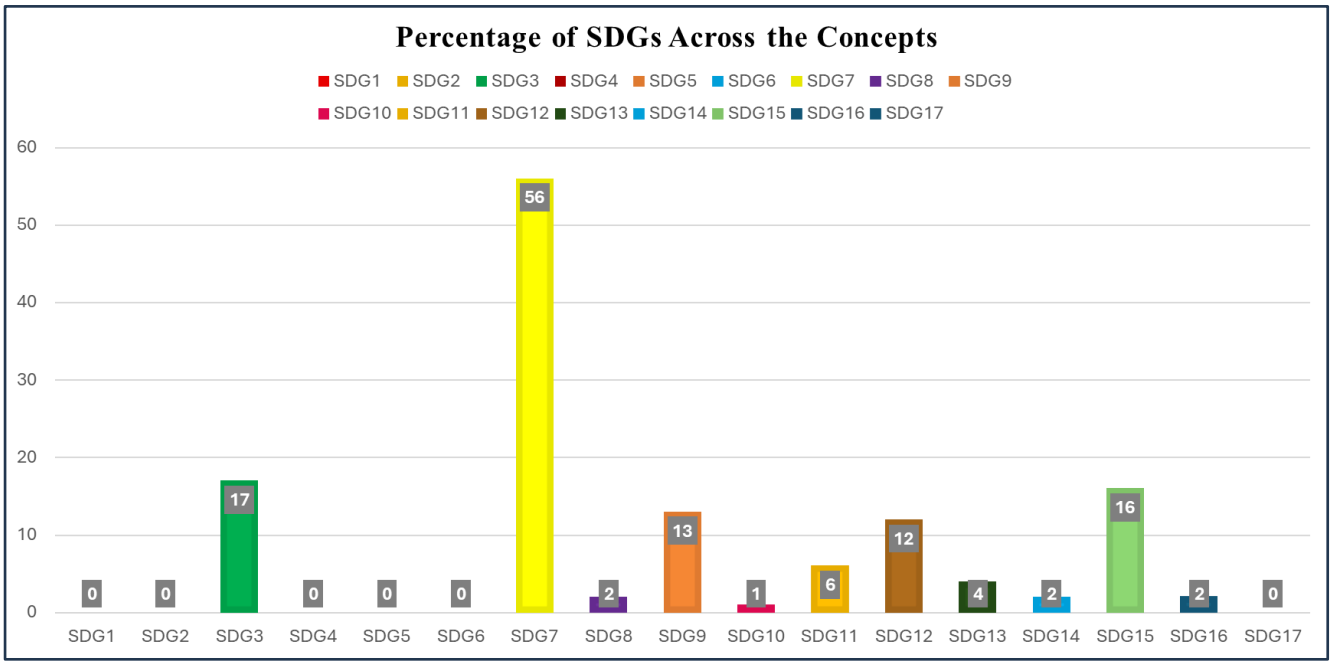
The results indicate that the three most common competencies are Critical Thinking (CT) at 69%, followed by Systems Thinking (ST) at 43%, and Collaboration Competency (CC) at 14%. The leading competencies, CT and ST, fall under the category of "ways of Thinking," related to the “Skills” Category in the Analytical framework, making this category the most prevalent across LAs. CC, which pertains to "ways

of practicing," follows, indicating activities involving student collaboration. Additionally, Normative Competency (NC) and Strategic Competency (SC) emerge as the least prevalent competencies at (2%) each, followed by Anticipatory Competency (AC) at 11%, Integrated Problem Solving (IPS) at 7%, and Self Awareness Competency (SAC) at 5%. The category “Ways of Thinking” associated with “Skills” is the most prevalent, while “Ways of Being," associated with the "Values" aspect of the Analytical framework, is presented as the least frequent across the LAs.

In this final step of the analysis, a column for "Emerging SDGs" was added, where references to SDGs that were not mentioned in the concept are considered by mapping them to the respective Learning activity. When the learning indicators were distributed across the concepts, and the SDGs that emerged from the Learning activities were added, a collective mapping of the SDGs per concept is presented in Figure (4.9).

Figure 4.9.

Percentage of SDGs across the Concepts including Learning Activities

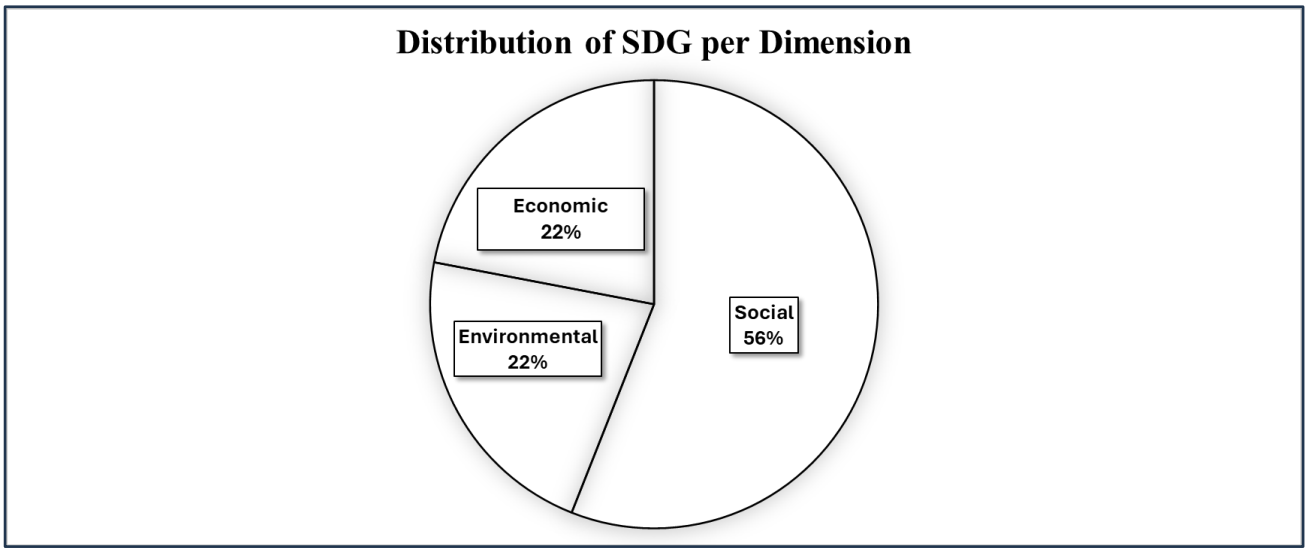


The data representation reveals that across the 4 main Themes comprising 13 Concepts of the entire curriculum, a total of 11 SDGs out of the 17 are present in the curriculum. These SDGs include SDG 3, SDG 7, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, and SDG 15. These findings align with the initial mapping where the SDGs mapped to the main topics to comprise the highest weight of presence in the different content materials analyzed from the curriculum. It also aligns with the findings of step 2, where the knowledge and skills of these same SDGs (7 and 15) comprise the highest weight.

The distribution of the SDGs across the curriculum per dimension based on the collective mapping of SDGs after the three steps is presented in Figure(4.10), showing that there is an equal share of the Environmental and Economic dimensions with (22%) for each, while the Social dimension constitutes the highest weight with (56%), indicating that the 3 dimensions of SDGs are present within the curriculum.

Figure 4.10

The Collective Distribution of the SDGs Dimensions across the 4 Themes



4.3. Interviews

The findings of the interviews are presented separately as teachers' interviews and Curriculum developers' interviews, and finally, the findings from the MOE interview.

4.3.1. Teachers' Interviews

Table (4.1) presents the relationship between some of the teachers' demographics and the main themes extracted from the findings.

Table 4.1.

The Relation between the Teachers' Demographics and some of the Main Themes

Teacher Code	School Type/Tier Tier 1 (T1) Tier2(T2) Tier3(T3)	Years of Teaching Experience	Years of teaching this Curriculum	Usage of the Techbook	Received PD for the Curriculum	Knowledge of SDGs	Knowledge of ESD
01	Private National/T2	4	1	Yes	Yes	Yes	No
02	Private National/T3	7	3	No	No	No	No
03	Private National/T3	16	3	No	Yes	Yes	No
04	Private National/T1	16	3	Yes	Yes	No	No
05	Public Experimental	18	3	No	Yes	No	No
06	Private National/T1	1st year	1	Yes	No	No	No
07	Private National/T1	2	2	No	No	No	No
08	Private National/T1	2	2	Yes	No	Yes	No

As shown in Table (4.1), all interviewed teachers teach at private national schools except teacher "05", who teaches at an experimental public school. However, private national schools in Egypt vary in terms of tuition fees, based on this I added the category of "School Tier" to identify the different levels of the private national schools the interviewees teach at, "Tier 1" being the highest in terms of tuition fees.

The responses were thematically categorized according to the deductive themes and the inductive themes as explained in the Data Analysis section (3.4.3) The deductive themes are: 1) SDG and ESD knowledge, 2) ESD Pedagogies, 3) Usage of the Techbook and the EKB Resources 4) Professional Development. The inductive themes are: 1) The limitations of applying ESD – related Pedagogies and 2) The strengths and Challenges of the Techbook Teachers' Guide.

4.3.1.1. Theme 1: Knowledge of SDGs and ESD

To get insights on this theme, the questions directly addressed the teachers' knowledge on the terms "Sustainability "and "SDG" Despite the fact that all interviewed teachers are Science teachers, only 2 of the 8 teachers reported that they know about SDG. They are all more familiar with the term "Sustainability", however, reported not using the term in their teaching. Teacher "01", who was one of the two teachers who reported their knowledge of SDGs said, "Students in primary four understand "sustainability" as a concept, however, they do not know about the SDGs". As for the concept of ESD, none of the teachers reported being familiar with the concept or even the term. This includes the teachers who were teaching in private top-tier schools and have received various professional development training in Teaching Science, either general or specific to teaching this curriculum.

4.3.1.2. Theme 2: ESD Pedagogies

The question addressing this theme did not directly include the term "ESD Pedagogies", however, it was an open-ended question on what pedagogies, or activity ideas they used for teaching the curriculum. Teachers "1",4", "5" and "8" have responded to this question using expressions like "student-centered learning", "learning through doing", "sparking students' curiosity" and "If I had more time, I'd do more projects". These expressions can imply the adoption of these teachers to ESD-related pedagogies, although all of them have reported the challenge of the time constraint that prevents them from doing activities due to the large amount of content. As for the other teachers, their responses showed that they follow the traditional didactic instruction, that is exams focused. When I tried to probe their familiarity or willingness

to use other pedagogies, their responses showed a lack of knowledge and motivation to adopt new ways of teaching. A specific question to get more insights related to this theme was a question asking them how they conducted the project theme and the interdisciplinary project that is done once per term. The same teachers (01,04,05 and 08) described the process of conducting the unit project by including elements of research, presentation, and creativity, again reporting that the time factor never allows for enough room to have the students do the project in class. The responses of the other teachers describing the project showed that it is done to be checked off their list of requirements and to be able to grade the students for "the project", which is part of the grade breakdown, however, the description implied a very shallow level of implementing the unit project. One example was a teacher describing the unit project of theme 1 "Living things", where the students assembled some toy animals in a fence". When that teacher was asked about the rationale of this activity or the process, the response revealed that there was none, but just having this described outcome. As for the interdisciplinary project, that is done once per term.

Another question addressing this theme was about their opinion of the top 3 skills their students should acquire through science education. This question was asked to probe the pedagogical knowledge of teachers in general and related to ESD specifically. Teachers 04","05" and "08", gave responses that reflected their knowledge of different skills, where the most frequently mentioned skill was Critical Thinking. However, the rest of the teachers gave responses that indicated their confusion about what "Skills" are. The questions were rephrased and translated to Arabic for clarification, and the responses remained the same.

4.3.1.3. Theme 3: Usage of the Techbook and the EKB Resources

Among the 8 teachers, only teachers "01","04","06" and "08" reported using the Teacher's Guide version of the Techbook. All the other participants reported not using the Techbook, and even the name sounded unfamiliar to them, instead they use "External Books" which are the books that are published by private publishing houses that are not affiliated with the MOETE but are aligned with the standards of the

curriculum. There was consensus among the group of participants that using the external books that they opt for this choice due to the straightforward presentation of information of the curriculum in a summarized, exam-oriented format, that allows them to just deliver the content of interest that would help students be prepared for the exams. This is in addition to the fact that the external books are structured in a way that focuses on “drilling”, providing plenty of question formats, however mostly targeting the basic levels of Bloom’s Taxonomy, Remembering, and Understanding.

As for the EKB resources, the findings are the same. Teachers who use the Techbook are familiar with the EKB resources. Teachers”04” and “08” reported a high level of dependence on the resources of the EKB, especially the explanatory videos on “Madrasetna” platform. They agreed the resources also helped them understand the concepts better during the planning phase, especially the resources that are designed for teachers specifically. As for the group of participants that do not use the EKB, there was an observable finding which is their general lack of motivation to use and integrate technology. Teachers “02”,”03” and “05” reported not having Zoom or knowing how to use it when they were initially contacted to invite them to participate in the research study as interviewees. The age factor, reflected in the years of teaching experience shown in the table, is found to be a common factor among this group. Teachers with the most years of teaching experience (03 and 05 respectively) are the ones who showed a relatively low engagement level with technology.

4.3.1.4. Theme 4: Professional Development

This theme was addressed by a direct question inquiring about the professional development the teacher received related to the curriculum. Only three teachers,”01”,”03” and “08” answered “Yes”. The Professional development described by these three teachers was organized by the MOETE, conducted in the duration between October and November, which is the first month of the first academic term. The training was 2- 3 hours, where attendees gathered physically in a room where a presentation was displayed. The presentation included displaying the curriculum objectives and philosophy, and resources that the teachers

can use. There were no hands-on activities conducted by the teachers. There was a presence of a representative from the MOETE, however, he/she did not provide any facilitation. The overall impression about that training was not positive as elicited from these three teachers' insights related to this aspect.

4.3.1.5. Inductive Theme 1: Limitations related to the curriculum structure and design.

All eight teachers reported that the content of the curriculum is too big for the time allocated to finish it, especially the first Theme "Living Things". Theme 1, containing three concepts, is supposed to be finished in four weeks. This puts teachers under the stress of having to finish before the first assessment, which takes place in mid-November. Teacher "04" said, "I feel relieved after the first assessment knowing that the most challenging phase of teaching is over". Teacher "02" expressed that the second term as well is challenging in terms of time, especially for the delivery of Theme 4, the last theme, which is usually rushed.

The other limitation according to the teachers' responses is the examples in the content that feel too foreign to Egyptian culture. According to the teacher "08", "Students feel they cannot relate to a lot of examples". Teacher "07," said, "Some terms are too complicated for the student's level".

4.3.1.6. Inductive Theme 2: Limitations related to the practice of delivering the curriculum.

Aligning with the limitation that all teachers agreed on, the content is too big, and this is reflected in the way teachers deliver the content. The time constraint prevents teachers from being motivated to prepare hands-on activities, rather they "prepare for the exam". That notion is specifically frustrating for the same group of teachers who expressed willingness to adopt more ESD-related pedagogies, as explained in the deductive theme 1. Other factors exacerbate this challenge, related to the environment provided by the school, especially the class size and the workload of the teachers. Teacher "05", who works at a public experimental school expressed how challenging the teaching environment is, having a class size of 70 -75 students. Although the attendance rate in this school is low, the class size is around 40 students. Another factor that adds a layer of challenge, is the workload. Due to the insufficiency of science teachers at that school, teacher "05", is the only teacher teaching Science to grades four to six. To accommodate this, the

school had to reduce the allocated teaching hours for this teacher in every grade, consequently, the time allocated for teaching the curriculum was reduced, making it more challenging to finish and reducing the room for activities. This also affects the teachers' motivation and affects their performance. Another challenge that teacher "05" has reported, which is the case in many public governmental schools, is the lack of resources on the school campus, as the lack of internet access to students and teachers as well as the lack of science lab tools and resources to conduct experiments.

Another limitation that was agreed upon by all teachers is the notion of a lack of adequate professional development to support them in teaching this curriculum. This applies to the group that received the MOETE professional development, reporting the lack of significant benefit, and to the other group that did not receive any professional development at all.

Finally, a valuable insight that was shared as a limitation by teacher "08", is the fact that students under 16 years of age cannot access the EKB except through their parents' accounts, as it requires registering through the Egyptian ID of the citizen, that is not issued before 16 years of age. This is a limitation as the teacher cannot assign students to directly use resources from the EKB, as this requires their parents' log-in, which is not guaranteed, as not all parents care enough to register on the EKB, and not all parents are expected to have the level of digital literacy that enables them to do so.

4.3.2. Curriculum Experts' Interviews

Two Curriculum Experts (CE) were interviewed. CE "A" has over 20 years of experience in teaching Science and holds a supervisory position where he has detailed knowledge of the new curricula and was indirectly related to the process of development. CE "B" was directly involved with the team developing the curriculum along with the Egyptian MOETE, and gave more insights related to the development of the curriculum design and the professional development design. The themes for presenting their findings are 1) Curriculum Development and 2) Professional Development Design.

4.3.2.1. Theme 1: The Curriculum Design

CE "A" shared insights from an experienced Science teacher's perspective rather than a curriculum developer. The general impression from these insights is that the curriculum design might be aligned with international standards, but the main challenge is in its application in the Egyptian context, given the challenges in the education system such as the class size, teacher-to-student ratio, teachers' status, and other factors. CE "A" said that "This curriculum might have had a better impact if these challenges were tackled first". The negative aspects of the curriculum structure as reported by CE "A" align with the insights shared by the Science teacher participants, such as the time constraint, the amount of content being too big, and the lack of contextualization in many of the activities. This is in addition to the lack of guidance for the assessments, which led to inconsistency across schools setting the assessments for this curriculum. By following up on teachers' applications delivering the curriculum, a considerable gap is found between the intended learning outcomes of the curriculum and the reality of the application. A lot of teachers must "skip teaching" parts of the concepts, so the scope and sequence of the activities of the concept lose their essence and compromise the quality of the outcome.

CE "B", who was directly involved in the development of the curriculum shared more insights related to the process of development and its underpinnings. The curriculum came as part of the bigger Vision of Egypt 2030, fulfilling SDG 4 "Quality Education". The main objective was to produce a curriculum with "Internationally benchmarked standards of Education", said CE "B", in addition to "changing the way of instruction". Thus, the Curriculum framework of Primary four was generally based on the 21st Century Skills based on the notion that the students prepared from KG1 to Primary 3 are prepared with skill sets based on the 21st Century Skills, Subject-specific Skills, and Literacy Skills. For Science, the Next Generation Science Standards (NGSS) with its standards, content knowledge, cross-cutting concepts, and Engineering and Design processes. There was also a great focus on SDGs as reported by CE "B"," SDGs were the guidance for designing the Interdisciplinary project that should happen once per term, where

students work on solving a real-world challenge". When asked about the issue of contextualization of examples and activities, CE "B" explains that a lot of contextualization already took place in the development process to make the curriculum more relatable and suitable for Egyptian students, however, the element of "the Global Context" was a requirement in this curriculum based on the Egypt Vision 2030. Furthermore, the issue of judging whether the activities are foreign to the students or not is a complex matter, as teachers and parents do not have 'the students' experience. Considering the vertical alignment of the curriculum of primary four as a continuation to its predecessor curricula of primary one to three, the examples, activities, and terms are not completely novel to the primary four student. Thus, when the "Students' Experience" is overlooked, the curriculum is misjudged for being too novel, too foreign or too complicated. However, foreign examples had to be present in the curriculum according to CE "B", not only because it was a requirement in the Curriculum Framework, but also because it is fundamental in Science Education that students are exposed to various examples that they are not necessarily familiar with, which further sparks their curiosity to learn and motivates them to develop and acquire skills of investigation and research.

4.3.2.2. Theme 2: Professional Development (PD)

This theme was elaborated on by CE" B", being a member of the Curriculum Development team and involved in the Professional Development design and plan for teachers. The insights shared by CE "B" on this aspect show that the plan that was set for the PD of teachers was massively impacted by COVID-19 in 2020. Before COVID, all PD training was face-to-face, following a "Cascade Model", where "Master teachers" would attend the training and cascade these pieces of training face-to-face to the other teachers in their respective schools. The level of engagement in this model was very high, and the feedback was positive for teachers of KG1 to Primary three. "The best time of PD in EDU 2.0 was from 2018-2021", said CE" B". After COVID, the direction was more towards the online modality, either synchronous or asynchronous. The Egyptian MOETE accommodated the changes imposed by COVID using an online

platform that was founded in 2018 called “The Professional Learning Journey mini-courses” (PLG), where teachers would upload videos of their teaching practices on the platform and would get points as incentives. The platform had a relatively high level of engagement although it was not incentivized materialistically. This platform was used for offering online PD in the form of short videos and mini-courses explaining the philosophy of the curriculum, its content, and instructional strategies. In addition to this, there were face-to-face courses that were required to complement the mini-courses online. Another PD type was the “Virtual Conferences”, which did not require cascading, where all teachers are invited to attend but it is not a requirement. The latter format seems to be the most common PD that the teachers have reported in the interviews. When asked if it is mandatory for teachers to attend these PD trainings, CE” B” expressed that it was in the plan to put more monitoring and evaluation measures for this process, but it has not been enacted yet.

4.3.3. The Former Egyptian MOETE

The themes for presenting the findings of the interview with Dr. Tarek Shawki, the former Egyptian Minister of Education and Technical Education are based on the 2 RQs, hence the themes are:1) The curriculum and 2)The Teachers

4.3.3.1. The Curriculum

“Coming into the Ministry, the objective was to re-imagine Education in Egypt", said Dr.Tarek, who was appointed to the office in 2017, where the overarching objective of the Government at the time was to implement reform projects for development in all sectors according to Egypt’s Agenda 2030 (see section 2.7.2). Given all the challenges and problems of the Education System in Egypt, changing the curricula was a top priority, given that the curricula have been stagnant for decades with very minimal changes related to the content. Still, the framework, philosophy, and approach have not been changed. The starting point was to envision the child graduating after thirteen years of school education, and how she/he should be prepared

and empowered to adapt to the fast-changing needs of the world. “It is not easy to forecast the product of education that long ahead, so the starting point was to set the objective of preparing graduates with internationally benchmarked standards, borrowing from international models and contextualizing to Egypt,” said Dr. Tarek. Therefore, the process of development began by focusing on the Center for Curriculum and Instructional Materials Development (CCIMD) of the Egyptian MOETE and partnering it with international entities that have proven successful in developing curricula, these were Longman, National Geographic, and Discovery Education, and Nahdet Masr for Arabic and religion. These partnerships were beneficial and a great learning experience for members of the CCIMD, which aspired to be an international center for curricula.

The Curriculum Framework was designed based on preparing students with the knowledge and skill sets that are integrated through the learning of national and Global Issues. 14 Life Skills were the basis of the design, divided into 4 main aspects; 1) Learning to be,2) Learning to know,3) Learning to work, and 4) Learning to live. It was remarkable from Dr. Tarek’s insights that the prime focus was on the early years from KG1 to Grade 3, where the main objective was to engage children in learning activities that spark their curiosity to learn, make them love school, and allow them to enjoy their childhood after school. Thus, the framework was designed for the years from KG one to Primary three as an Interdisciplinary framework, that is “Theme Based”, breaking as much as possible the silos of “subjects” and focusing more on “Themes” that are tackled by the different disciplines, taking into account Literacy and Writing Skills. In addition to this, KG one to Primary three had no assessments, to nurture the concept of “Learning is the objective” rather than “Exams are the objective”. Also, Technology integration is minimal in these early years, to focus on building literacy, writing, and interpersonal skills, then starting primary four, technology integration increases to 50% and then gradually increases to 70% through the preparatory and secondary stages. The Curriculum Framework as well was designed in a way that no homework is assigned to children until grade three, to give them more room to play and enjoy their childhood.

4.3.3.2. The Teachers

"The majority of the teachers did not welcome the change", said Dr. Tarek, describing the resistance that was faced by teachers to accept and begin to apply the new Curriculum framework. Teachers were accustomed to making very minimal changes in the content they taught every year, so this transformation was inconvenient to many, especially the more senior teachers, having to do more work on lesson planning. Another reason was the fact that the curriculum marginalized the concept of assessments being the main objective of learning, which has confused teachers who "teach for the exam" and has caused a higher dissatisfaction among the many teachers who give "private lessons". That is specifically in the early years (primary one to three) when there are no exams at all. This resistance has been one of the biggest barriers to helping Project EDU 2.0 launch smoothly, especially in the initial phases.

It was fundamental to the success of this new curriculum framework that teachers change "their ways of teaching". "Many teachers did not have the skills that we needed them to teach to the student", said Dr. Tarek This is why a Professional Development plan was designed by the CCIMD in collaboration with the partners, to equip teachers with the knowledge and skills of the teaching methods that can cater to fulfilling the objectives of the new curriculum framework that is "Skills' Based". To further enhance the support for teachers with ways and ideas of teaching the new curricula, the Egyptian Knowledge Bank (EKB) was made accessible to all teachers and provided plenty of resources per grade level and subject for teachers to access. "The teacher has everything they need to know to teach a concept or an activity through the Teacher Guide versions of the Ministry Book, this was further supported by PD and EKB resources," said Dr. Tarek "Only teachers who wanted to develop would make use of these resources".

4.3.3.3. The Challenges

This transformation of curricula was revolutionary as described by Dr. Tarek; however, he acknowledged the presence of mistakes and defects. The project launched in 2018, less than one year after the appointment of Dr. Tarek as the Minister, which was a relatively short time frame given the scale of the

transformation. However, Dr. Tarek said, “It was better to get the job done and get everyone working on changing the status quo, expecting mistakes to arise along the way and deal with them, rather than taking a much longer time planning on paper through committees.” The major challenge according to Dr. Tarek was the resistance to change from teachers and parents “Reforming Education is about changing the culture”, said Dr. Tarek, pinpointing the importance of having the reform on a governmental scale, not just being the responsibility of a Ministry. The overlooked aspect that Dr. Tarek mentioned was taking into account the psychological aspect of how to introduce the change to the different groups perceiving it, for example, if parents were given the choice of enrolling their children in EDU 1.0 or EDU 2.0, knowing that EDU 2.0 was the more developed systems, would the intensity and resistance of parents be the same ?”. Also, Dr. Tarek referred to the other challenges in the system that implemented EDU2.0 as more challenging, such as the status of the schools, and the class size, but highlighting the problem of teachers’ preparedness as one of the major challenges, saying that all of these factors were taken into consideration to be reformed in parallel with the execution of the curriculum reform.

Also relating to the challenge of resistance to change, parents' buy-in was an added layer, especially mothers. “We should have started by raising awareness for the mothers first, as they are the key players in this reform process. The mother is the decision-maker of what is best for their child. No mother would want less than the best for her child, she just needs to be educated on what that best is” said Dr. Tarek. Stopping private lessons, and learning to learn, not for the exam, are made possible if the mother knows that this is best for her child.

Additionally, Dr. Tarek highlighted another challenge stemming from cultural norms, known as the "disease of assessments" among Egyptians. Across generations, the culture has ingrained the idea of learning solely for exams. As long as this mindset persists, parents will prioritize their children's education based on exam grades, students will focus solely on exam preparation, and teachers will cater to this narrow objective, neglecting the broader goal of skill acquisition. Although a plan to reform assessments existed,

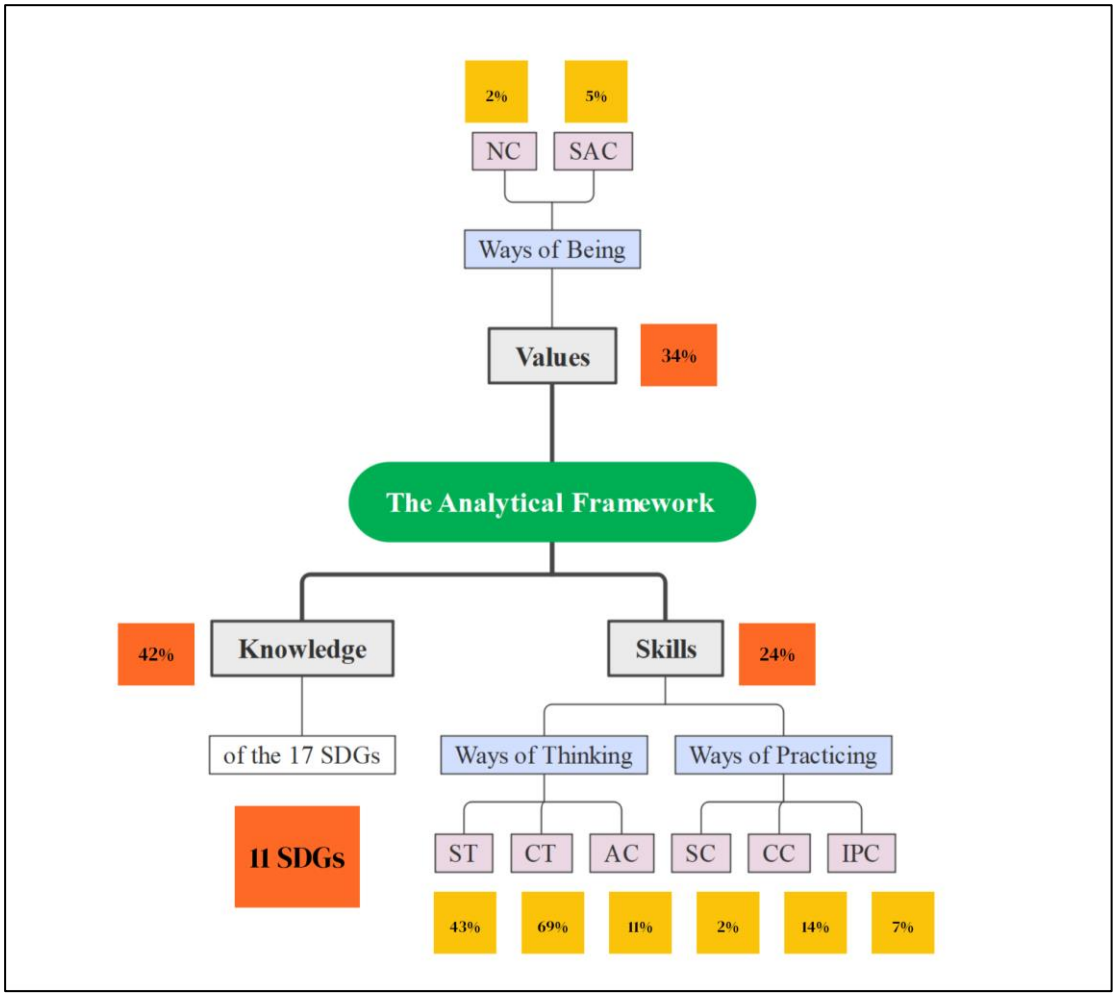
resistance within the education sector necessitated a gradual rather than immediate implementation of change in this aspect.

4.4 Summary of Findings

The document and the content analysis indicate the presence of SDGs and ESD features in the curriculum, presented in the context and the content of the design. As shown in Figure (4.11) showing the findings of the categories of the analytical framework, the analysis of the learning indicators showed that 11 SDGs are present out of the 17 in the curriculum, only two SDGs of which are explicitly mentioned, one in each of the two Interdisciplinary Projects that happen once per term. The knowledge strand of SDGs is of the highest weight, followed by the values and finally, the skills, indicating the consideration of values related to the SDGs in the learning indicators. However, the analysis of the learning activities showed that the ESD competencies related to the Values, presented in the Normative and Self-Awareness Competencies are of the least weight, while the skills related to the Ways of Thinking, specifically Critical and Systems Thinking are of the highest weight.

Figure 4.11

Findings of the Categories of the Analytical Framework



The teachers' interviews revealed that the knowledge of ESD is deficient, presented in that all teachers reported their lack of familiarity with the term "ESD" in the interviews. Few teachers have knowledge of SDGs and the concept of sustainability and its relation to Egypt Vision 2030. ESD pedagogies are directly linked to the caliber of the teacher and the school tier, relating to the Professional development and the learning environment respectively. Motivation is a key player in teachers' performance that affects their willingness to apply ESD pedagogies and use the Teachers' Guide and EKB resources

effectively. Motivation is related to personal variation and conditions of the working environment, manifested in the class size and the teacher workload, which is more challenging in public school. Receiving Professional Development specifically related to this curriculum was inconsistent. This finding was explained by the curriculum experts and Dr. Tarek highlighting that the plan of the PD before COVID was more structured and that the cohort of teachers that made the best use of the PD plan were the ones receiving PD from 2018 to 2020. A multitude of factors was revealed to be of impact on the success of EDU 2.0 in general and this curriculum specifically, as revealed by the insights shared by Dr. Tarek Shawki and discussed in section (4.3.3)

Chapter 5: Discussion and Conclusion

The discussion of the findings in this chapter is presented by addressing the two RQs, beginning with the triangulation of findings, followed by the discussion, where critical reflection, connects the main findings to the literature review, problem statement, purpose, and the RQs of the study. This is followed by unpacking the findings into challenges and their implications, and finally ending with the conclusion, proposing recommendations and potential opportunities for future research.

5.1. Triangulation of Findings

Three data collection tools were used for exploring the central phenomenon and answering the 2 RQs, the Document Analysis, the Content Analysis, and the Interviews with Science Teachers, Curriculum Experts, and Dr. Tarek Shawki, the former Minister of Education and Technical Education. The results of the Document Analysis reveal an emphasis on Education for Sustainable Development (ESD) evident in the description of the Curriculum Framework in section (4.1.1) The overarching objective guiding the development of the EDU 2.0 curriculum is the attainment of the Sustainable Development Goal 4 (SDG 4) - Quality Education. Notably, the explicit inclusion of terms associated with sustainable development and the incorporation of project-based assessments aimed at addressing real-world challenges aligned with SDGs

showcase the commitment to ESD principles. From a curriculum design perspective, the provision of activities and teacher support aimed at facilitating these activities is supposed to enhance educators' knowledge base and motivation to engage students in such activities. However, by looking into the pacing guide that is presented at the beginning of each concept, it is notable that the duration allocated for the activities is not realistic. This finding disregards the factors that are related to the learning environment such as the class size, student to teacher ratios and the teacher's Classroom management skills. This finding aligns with the findings from the teachers' interviews where all of them expressed that their main challenge was the time constraint.

The findings of the Content Analysis as well align with the findings of the Document Analysis, hammering on the notion that the curriculum considers the presence of SDGs, and ESD competencies from a Curriculum Design perspective. Ten out of 17 SDGs are related to the concepts of the curriculum with the presence of the three SDG dimensions with emphasis on the Knowledge strand of the SDGs. In terms of ESD Competencies, it is evident that the competencies related to thinking skills are the most considered in the curriculum, followed by the competencies related to practice. Competencies related to the "Values" aspect are the least considered and may need revisiting. The general outcome of the content analysis reveals the implicit presence of the knowledge and skills related to SDGs, and the competencies related to thinking skills as well; however, the explicit mention of SDGs is only restricted to the two Interdisciplinary projects.

The findings of the interviews with science teachers show the connection between the teacher's self-efficacy and the extent to which he/she is motivated to apply the curriculum design. The design of the teacher's guide as presented in the analysis is supportive to teachers who are motivated to apply. There was also a direct relationship between the teachers' usage of the techbook and the EKB resources and the knowledge of ESD-related pedagogies despite the lack of knowledge of ESD as a concept. The self-efficacy of teachers is found to be a catalyst for teacher's development and high-quality performance. However, other factors, such as time constraints and the learning environment, play a pivotal role in the motivation of

teachers to change their traditional ways of teaching and make use of the Teacher's Guide features of support to teachers.

5.2. Discussion

Referring to the Problem statement in section (1.2.), the persistent challenge of students graduating without essential skills has plagued Egypt for decades (Roach, 2022). The education system must prioritize equipping students with the skills necessary to tackle real-world challenges. By framing these challenges within the framework of the 17 Sustainable Development Goals, there is a clear emphasis on the importance of Education for Sustainable Development (ESD), where the key goal is to develop students' sustainability competencies so they can contribute to the transformation of society for sustainability (Rieckmann, 2022). The interpretation of "skills" within the context of ESD has evolved to "competencies", where the total set of knowledge, skills, and values are the intended outcome of learning, which is a broader scope than "skills". This requires that the learning tackles the three domains during the learning process: Cognitive, Socio-Cultural, and Behavioral altogether (Eilam & Trop, 2010).

Consequently, education should not only address cognitive aspects but also social and behavioral dimensions. In Egypt, there is a noticeable lack of emphasis on ESD, as discussed in section (2.7.4.).

EDU 2.0, the education reform initiative in Egypt, is designed with the primary objective of achieving SDG 4. Through the findings of document analysis and interviews with CE "B" and Dr. Tarek Shawki, it is evident that the essence of EDU 2.0 aligns with the goals outlined in the Vision of Egypt 2030. This alignment is apparent in the context of development highlighted in the introductory section, and the note by Dr. Tarek Shawki, as well as in the philosophy and approach of the Techbook, which emphasizes the preparation of "globally competent citizens". Furthermore, interview findings from Dr. Tarek Shawi and CE "B" further reinforce this alignment, emphasizing the emphasis on SDGs and the preparation of students to address real-world challenges during the curriculum planning phase.

The purpose of this study, as outlined in section (1.3), is to utilize the curriculum at hand as a case study to examine the integration of ESD and ESD Competencies, as well as the application of ESD Pedagogies. This purpose is framed by two central research questions that cover both the analysis from a curriculum design perspective and its implementation. The type of curriculum based on the objective according to Kelly (1977) defined in the study is the Curriculum as Product, concerned with the learning outcomes as ESD Competencies, and Curriculum as Process, concerned with the process and application. Also, it constitutes the presentation of the "Total Curriculum", which encompasses the "Planned Curriculum" and the Curriculum received by students. After conducting the analysis through Document and Content Analysis, the findings revealed an emerging need to differentiate between the terms "integration" and "inclusion" of competencies. The triangulation of the findings indicates a gap between the "Planned Curriculum" and the curriculum students receive due to inconsistencies in how the curriculum is delivered by teachers, influenced by various factors. The semantic meaning of "integration" denotes the combination of one thing with another to form a whole. In the context of Education, it is the holistic union of homogeneous and heterogeneous components of systems in solving educational problems (Karabaevna, 2020). To assert that "Integration of Competencies" is achieved in the curriculum, both parts of the Total Curriculum—the Planned and the Delivered—must be considered. Therefore, for greater specificity in communicating the findings, the term "inclusion" of competencies is added. This differentiation is necessary due to the evident gap between what is "included" in the curriculum design and what is delivered, challenging the claim of "integration".

In the ESD context, "Integration" of ESD has to include the four fundamental aspects of learning according to Eilam and Trop (2010) to ensure that the three domains, Cognitive, Socio-emotional, and Behavioral are considered. For integration to be achieved, all domains have to be tackled where a Constructivist learning approach is irreplaceable, to achieve the objectives explained by Eilam and Trop (2010) and the proposed ESD pedagogies outlined as "Student-Centered Learning ", Hands on Minds on

Learning “and “Active Participation”. This perspective on ESD integration further hammers on the interplay between the curriculum design and its facilitation, where both have to be aligned for integration to be achieved.

The findings of the document and the content analysis of the Teachers Guide version of the Techbook ensure the inclusion of ESD as a concept and ESD competencies, as well as the provision of Constructivist pedagogies to facilitate the delivery of the activities designed in the curriculum.

ESD is evident in the context, philosophy, and approach of the Techbook as described in the findings of the Document Analysis section (4.1.1). It is evident as well that the requirements of Scientific literacy and the NOS are fulfilled in this Science curriculum, hence consolidating the presence of ESD indirectly, therefore the curriculum is meant to empower the students with the skills or competencies needed to solve real-world challenges. Also, the analysis refers to the inclusion of the four elements of ESD as per Eilam and Trop (2010) with variable degrees. Academic Learning concerned more with the content, which in my opinion, is the easiest to achieve, is fulfilled presented by the finding of the content analysis related to the “Knowledge”strand of the mapping of the Learning Indicators, showing that it is the highest (42%) of the three strands (K/S/V). Multidisciplinarity is explicitly stated and presented in the 2 Interdisciplinary projects of terms one and two, where the prompt is to solve a real-world challenge mentioning explicitly an SDG. In addition to the fact that interdisciplinarity is a smaller scope of Multidisciplinary, this can be criticized as the allocation of the project comes at the end of the unit, where the project is to apply the learning rather than to learn. Also, according to the teachers who were interviewed and asked about this project, it shows that the time never allowed teachers to do the “interdisciplinarity” planning needed, and although the project is graded, it ends up as a simple poster or model that the students worked on, mostly at home not in class. The third element, the multidimensional aspect that considers the factor of space and time in the concepts taught, is what allows students to develop Anticipatory Competency, is also present in some of the learning activities; however, it is among the least weight of the thinking skills as per the content

analysis, where the Anticipatory Competency only constitutes 11%. This is not a reflective indication of the inclusion of the Multidimensional aspect as the Anticipatory Competency was mapped in some learning activities that did not necessarily include the factors of space and time, thus this element cannot be communicated from the findings. Finally, the Emotional element, which is responsible for the development of values, tackles the sociocultural and behavioral domains, comprising the Normative competency and the Self-awareness competency. The findings from the study related to this aspect are not conclusive, as the "Values" strand (34%) of the learning indicators per SDG is higher than the skills strand (24%), however, the Normative Competency and the Self Awareness Competency mapped from the learning activities are among the least of all the competencies at (2%) and (5%) respectively. This may indicate that the "Values" are considered in the curriculum as an objective, presented in the findings as their percentage in the learning indicators, yet the actual activities are more focused on the competencies related to thinking and practicing, tackling the cognitive domain, and might need to include the emotions in those activities to help students do more reflection and be engaged emotionally to consolidate the ethics needed for sustainability presented in the Normative and Self Awareness Competencies.

As for the constructivist pedagogies, particularly Student-Centered, Hands-on, Minds-on, and Active Participation approaches, they are prominently featured in the curriculum design. This is evident from the document analysis findings, which highlight "Student-Centered" and "Hands-on Learning," along with "Globally prepared citizens" through the integration of career, technology, entrepreneurship, and life skills, as key approaches to achieving the objectives of the 3D learning model framework embedded in this curriculum. Moreover, the learning activities, referred to as "printable resources" in the techbook, demonstrate the incorporation of numerous activities aligned with these pedagogies. However, the implementation of these pedagogies by teachers remains an unmeasurable variable, but the findings of the teachers' interviews indicate that they are "included" in the curriculum but may not necessarily be fully integrated into teaching practices.

Teachers remain to be the key to “integration”. Teachers do not necessarily deliver the curriculum the way it is designed hence compromising on the objectives and the notion of “integration “ of competencies. There is an evident inconsistency among the teachers who were interviewed concerning the way they teach the curriculum. To discuss the causes of this inconsistency, the reasons reported by teachers for not applying much of the constructivist pedagogies are analyzed. The reasons reported by teachers are related to the limited time, and the quantity of the content being large are the two reasons where there was consensus from all eight teachers. Other factors were related to the conditions of the schools where these teachers work. The particular one of interest is Teacher “05” who teaches at a public school. Although the findings of one participant cannot be generalized, it was stated that these conditions are prevalent in most of the public schools. As communicated in the findings of the interviews section (4.3.1), the reasons for teachers' inconsistency in the delivery of the curriculum are broken down into two categories: reasons related to the curriculum design, the content quantity, the time constraint that is agreed upon from all eight teachers, and the irrelevance of some of the examples in the concepts as reported by some. The second category is related to the learning environment. In my analysis, the notion of the teachers’ values and their level of motivation is a key factor.

5.2.1. Challenges and their Implications

Unpacking the different challenges to integrate ESD competencies, they are grouped into challenges related to the curriculum design, challenges related to the teachers' application, and other challenges that do not fall under these two categories but were revealed through the findings of the study.

5.2.1.1. Challenges Related to the Curriculum Design

The first challenge related to the curriculum is the huge amount of content given the time, as reported by all eight teachers. This was my reflection as well as doing the document analysis, my impression of examining the pacing guides at the beginning of each concept was that the pacing is

unrealistic, and the time is too tight for the activities described. That reflection disregards the factors related to the learning environment, specifically the class size, and the teachers' classroom management skills that have a direct impact on the time management in class. This challenge jeopardizes the application of constructivist approaches, as teachers feel pressured that they need to just finish the curriculum, so they resort to traditional instruction, a teacher-centered method, based on instruction and drilling, to prepare for the exam. This decreases the level of motivation of teachers to conduct the activities of the techbook, and hence compromises the acquisition of competencies. On some other occasions, as reported by CE "A", teachers opt for "choosing" certain activities and skipping the rest, and at times changing the sequence of conducting the activities based on the factor of "time", in which case the logic of the sequencing of activities, considering "scaffolding" as described in the approach of the techbook, is compromised.

The literature reveals that the challenge of teachers feeling the pressure of time and the curriculum being too much for the time allocated for teaching is a universal one. A study by B. D. Taylor (2022), tackles this challenge and its negative impact on teachers' motivation and performance, and consequently the learning experience of students. It is a direct reason for a lot of teachers quitting their jobs in the United States reporting the cause to be the burnout of the teachers. "There is too much curriculum and not enough time to teach it" (Taylor, 2022, p.31). A reductionist approach in Curriculum design is the ventral recommendation given by this study, meaning that the content specifically related to " content knowledge" to be reduced, to give more room for activities, especially with the rise of Artificial Intelligence (AI), where students will very easily access knowledge, so education should be more focused on students acquiring skills rather than knowledge, as skills cannot be taught by AI. This insight is specifically relevant to this curriculum, based on the finding that the "knowledge" strand has the highest weight, based on the findings of the analysis of the Learning Indicators.

Another challenge related to the curriculum is the "relevance" of examples to the Egyptian context. The triangulation section shows how the findings regarding this aspect are conflicting. Some of the teachers

and CE “A” agreed that the examples given in the techbook are irrelevant to the context of Egypt, however, CE “B”, has elaborated on this issue explaining that a science curriculum has to include global examples, especially that the integration of the Global Context, was a requirement in that curriculum framework. Furthermore, the vertical alignment considers that aspect, so if teachers consider the prior knowledge of the students, they will realize that a lot of the examples that are alleged to be “too foreign”, were actually introduced in the predecessor curricula. My impression regarding this aspect is that it would be perceived according to the readiness of the students and their affinity to learn about organisms that they have never heard of before. I also believe that the perception of the teachers of these examples has the biggest impact on the perception of students. A good Science teacher in my opinion should always spark the curiosity of students and motivate them to learn. It is really the teachers’ mindset about this issue rather than the students.

Relevance is a key factor in science learning as emphasized by Newton (1988) and explained in section (2.5.3) as it increases the engagement of students and their ability to relate to life applications. Relevance allows for context-based education and helps teachers engage students to construct new knowledge based on their own experiences. Consideration of relevance is important in a science curriculum, however, sparking curiosity is an important aspect as well. According to Lindholm (2018), Science teaching should expose students, especially in the younger ages, to knowledge that is ambiguous to engage the mind. In preschool, it's important to encourage curiosity by letting kids ask questions and explore a lot. This helps them become friends with nature and learn about the world around them. As they get older, their curiosity should focus more on learning about different things in the world using facts and specific words.

The way teachers teach is what makes an “out of context” example relatable to the students. According to Zinser (2012), when teachers do not help students make connections of their learning to their lives, students fail to grasp the significance and relevance of what is being taught. As a result, topics may appear abstract and lacking in practical application or relevance to them. It is the responsibility of the

teacher to explicitly make these connections or facilitate opportunities for students to discover them independently. By doing so, students can find personal meaning in the material, internalize it, and articulate it in their own words. This process addresses the fundamental question of "why do I have to learn this?" and can lead to increased motivation. Therefore, relevance is the responsibility of the teachers rather than curriculum design.

5.2.1.2. Challenges Related to Teachers' Application

To address these challenges, I categorize the factors hindering effective curriculum implementation into two groups: intrinsic factors related to the teacher and extrinsic factors related to the teaching environment.

Intrinsic factors as evident from the findings are the teachers’ mindset towards the change, the teachers’ preparedness and skills, and the teachers' motivation to perform better. Extrinsic factors are related to the learning environments presented in the class size, the workload, and the general teachers’ conditions in Egypt.

It is notable from the findings of the teachers' interviews and the insights shared by the two curriculum experts and Dr. Tarek Shawki, that in general, teachers’ perceptions to EDU 2.0 is more on the negative end, especially in its initial launching phases. By and large, people resist change. Resistance to change is a multifaceted phenomenon influenced by numerous factors. According to a Psychology, it stems from a fear of the risks linked with change (Eagle, 1999). The literature shows that it is not uncommon for teachers to resist changes in educational reforms. A study conducted in Kazakhstan by Suyundikova (2019) explores teachers' perceptions of changes in the education system. It highlights that teachers are pivotal in implementing curriculum changes and are often viewed as primary change agents. However, the study suggests that some teachers may resist this role due to their attitudes. It also highlights the importance of teachers adapting their behavior to welcome curriculum changes, emphasizing how their beliefs impact the success of educational reforms.

Another study by Ngqondi (2012) in South Africa refers to the notion of the change of the standards as part of the reform, perceived by the teachers as being "imposed" on them, making them less motivated to implement those changes. The study highlights that for teachers to effectively fulfill their roles as agents of change, they require enabling conditions. This involves acknowledgment of their pivotal role, as well as consultation and inclusion in the development of new curricula. If they are tasked with implementing externally imposed curricula without their input, they are likely to disengage from the process, as it makes them feel they lost their ownership and agency.

Another study related to teachers' resistance to change by Gardner (2013) focused on the lived experiences of twelve teachers and school administrators during a major change in their school district. It discusses the factor of communication with teachers, specifically the mission and objectives of the new changes. This study focuses on this aspect relating specifically to school leaders and their role in fostering a school culture that supports the changes in the education reforms. It denotes that school leaders should take on the responsibility of this communication, as this directly impacts fostering a positive culture in schools. This study hammers as well on the importance of the inclusion of teachers in the communication of the changes during the planning and development phases, rather than facing them with the changes after they are done. "It took an unusual amount of time for teachers to get on board with all of the changes because of a flood of emotions and feelings of inadequacy resulting from their exclusion from the process". (T. B. Gardner, 2013, p.114).

It was not conclusive from the findings of the interviews that teachers felt excluded, but it was evident that the changes when announced, stirred feelings of anxiety and stress, especially since the textbooks were not delivered until the beginning of the academic year (2021 for the Science Techbook), which further overwhelmed the teachers as they had insufficient time to do the lesson planning.

The literature thus confirms that resistance to educational reforms among teachers is not uncommon and is directly linked to their motivation levels to embrace and implement these changes to the best of their

abilities. The level of motivation of teachers to perform well is influenced by other factors. Self Determination Theory (SDT) explains that intrinsic motivation helps people be autonomous and constantly work on being and doing their best (Ryan & Deci, 2020). It is a personal variation however, not all teachers are at the same level of intrinsic motivation, and hence, extrinsic motivation should be effective to help teachers maximize their professional performance. This is primarily the role of school administrators and educational policies and therefore, revisiting the teachers' status, appraisals, support, and providing more professional development opportunities are all important considerations to increase the motivation of teachers and maximize their professional performance (Huai Dong, 2021).

Challenges related to the learning environment in the context of this study are primarily presented in the large class size, the heavy workload of teachers, and the lack of resources. This problem is a common finding in Egypt, specifically in public schools (UNICEF, 2018). Research investigating the correlation between classroom size and education outcomes has shown that smaller class sizes correlate with enhanced academic achievement and improved teaching methods Hall (2000). This results in more manageable teacher workloads, enhanced student behavior, and higher academic performance, further motivating the teacher to plan and conduct more activities.

5.2.1.3. Challenges Related to the Inherited Beliefs and Culture

Culture plays an important role in the way parents make decisions related to the education of their children and the way they perceive and judge how their children are educated. For decades, the culture of people related to Education has been based on the notion that "Excellence" in education translates to the ability of the student to enroll in the majors that Egyptians named for decades as "Kolleyat Al Kemma-كليات القمه" which is the Arabic expression meaning the "top-notch majors". These majors are Medicine, Dentistry, Pharmacy, and Engineering. It was every parent's dream that their child would grow up to be either a doctor or an Engineer. I have encountered this perception firsthand growing up throughout my schooling years. I ended up being a Dentist, and three years after I graduated from University, I made a

career shift to teaching when I realized that I was more passionate about education. The culture as well was the reason why this shift was “shocking” to many, as being a Dentist to Egyptians is a more prestigious job than teaching.

These “top-notch majors” require the highest scores in Thanaweyya Amma- The Egyptian Secondary Education Certificate, and hence, if a student fails to score very high in Thanaweyya Amma, she/he does not get the opportunity of enrolling in one of the top-notch schools, which comes as a disappointment to many parents as the system does not allow for re-examination or dropping subjects as in the IGCSE system or the American Diploma.

This has lent itself to the culture being too focused on the assessments and the grades. “Success” to students and parents in Egypt is directly linked to exam grades, not to the knowledge or skills acquired through learning. Therefore, schools' and teachers’ criteria of success are only framed in the scores that their students achieve with little or no focus on acquiring skills and the objectives of good quality education. Traditional teaching methods rely solely on teacher-centered pedagogies. Teaching is mostly teacher talking time and lots of drilling to prepare for the exam. This is further exacerbated by the challenges related to the learning environment presented in the large class size and relatively big teacher load, further compromising the quality of teaching and instilling the belief at the parents’ side that the school is not competent enough to guarantee that their children will score high on exams. This has led to another prevalent phenomenon in Egypt, private lessons, or private tutoring.

Sobhy (2012) explores the causes and implications of the private tutoring phenomenon in Egypt. “Private tutoring’ in this article refers to classes provided for a fee, which take place outside and in addition to the formal school timetable with the aim of improving official exam performance” (Sobhy, 2012, p.41). Private tutoring sessions, typically occurring once or twice weekly throughout the academic year often incorporate supplementary revision and examination sessions. In Egypt, two primary forms of tutoring exist. Firstly, officially endorsed after-school sessions, known as 'in-school tutoring' (majmu‘at al-taqwiya al-

madrasiya or magmu‘at), are conducted by school teachers after regular school hours, adhering to Ministry of Education regulations. Mandated by Law as an initiative to counteract private tutoring and alleviate financial strain on families, these sessions have not effectively fulfilled their intended purpose. Secondly, private tutoring, referred to as 'durus khususiya,' is conducted either in students' homes or increasingly within dedicated tutoring centers. Since the mid-1990s, there have been more and more tutoring centers. They serve people from different economic backgrounds, but there are more of them in cities. This phenomenon persists to date, as reported by Dr. Tarek during the interview, and constituted one of the challenges that further hindered the buy-in of teachers to the changes in the curriculum whose framework is based on “learning to learn" rather than " learning for the exam” as he said.

Under the umbrella of the culture that is too focused on assessments, the criteria of a good source for studying lies in its inclusion of question banks with an abundant number and forms of questions after each lesson, unit, and a specific section for exam preparation. The phenomenon of the “ Al Ketab Al Kharegy – الكتاب الخارجى” meaning the “External Book” is another prevalent one in the culture of Egyptians in the realm of Education. The External Books are those designed and published by private publishing companies under the approval of the Egyptian MOETE for publishing. The External Book offers the content of the Ministry Book, but in a more summarized format, where the lesson is presented in clear bullet points under titles and subtitles, with sections throughout the lesson to give students “tips” on how this content is tackled in the exams. This is in addition to question banks, and provision of all the previous exams of the previous years, to train students for the exam. The success criterion for an External Book lies in the notion of preparing and training students on all sorts of questions related to the subject so they won’t be “surprised” by a question they haven’t been trained to answer in their exams. In my research for literature to give insights on this aspect, I found that there are no studies reporting on this phenomenon to this date. However, Teachers’ interviews revealed that five out of eight teachers do not use the Techbook but rather External Books. Dr. Tarek Shawki has referred to this phenomenon as well as one of the challenges that hinder the proper

implementation of the objectives of the curriculum framework of EDU 2.0. He also discussed that the development of the Ministry Books alone was not enough to shift the focus away from external books, referring to underpinnings related to the External Books being a business that needed to survive, in addition to the notion of culture, perceiving the External Book as a more superior source for learning by students and parents, and consequently, teachers use it as a "shortcut" for learning.

From the interviewed teachers' perspectives, the External Book saves time for lesson planning as it is already organized and "to the point" as reported by teacher "02". In addition to that it is the primary source for "drilling", even assigning students Homework from it and using it to generate questions for quizzes and tests.

All of the above mentioned challenges are related to the culture of Egyptians regarding Education. The perception of the changes in curricula was not welcome, with the resistance being the most during the initial phases. The graphs below are accessed through a Media Agency, analyzing the positive, negative, and neutral responses on the social media platforms of " Madrasetna Channel" one of the Egyptian MOETE e-learning channels for the Academic year 2020-2021. 55% of the reactions of people to the posts of the MOETE on social media are negative, while 35% are positive. Figure(5.2), shows a breakdown of the different topics that people reacted to on social media,showing the the highest share of negative comments was related to the change of the education system, followed by primary four.

Figure 5.1.

The Positive, Negative and Neutral Reactions

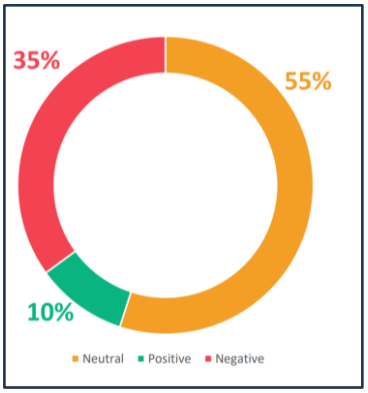
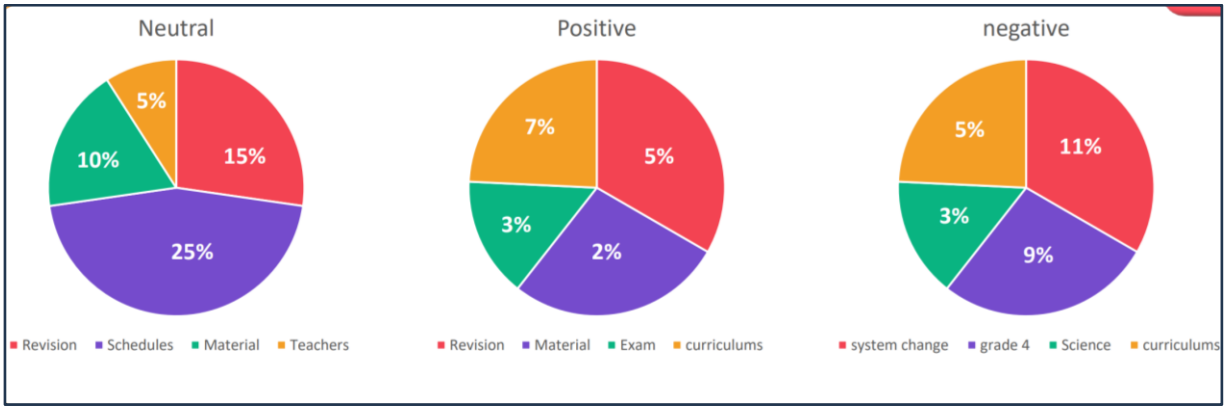


Figure 5.2.

The breakdown of Positive, Negative, and Neutral Comments



Source: A Media Agency (2021-2022)

Figure (5.3) shows a sample of the negative comments on Facebook, where people are mostly complaining about how big the curricula are, and how the level of complexity of the content does not suit the grade level of students in the parents' views, making it an overwhelming challenge to both the students and their parents.

Figure 5.3

Sample of the Negative Comments on Facebook

Figure (5.4) shows a sample of the positive comments on Facebook, mainly praising " Madrasetna Channel", that is one of the Egyptian MOETE sources that provides instructional videos for students on different subjects in the different grade levels. People in the comments are expressing its added value in supporting the students and praising the quality of teachers conducting the lessons in the videos.

Figure 5.4.

Sample of Positive Comments on Facebook

5.3. Conclusion

The curriculum does indeed take into account Education for Sustainable Development and the incorporation of Sustainable Development Goals. However, the term "Integration" may not accurately depict the situation. The issue lies in the inconsistent implementation of the curriculum and the achievement of its objectives as envisioned, with ESD at its heart. This inconsistency among teachers in implementing the curriculum stems from the varying levels of motivation of teachers framed in their Self-Efficacy and Self-Determination and the challenges related to the curriculum design and the conditions of the learning environment, specifically in public schools. For this curriculum specifically, the time allocation for the amount of content is another added layer of challenge that hinders the implementation of the activities and fulfillment of its objectives as designed. Finally, the general culture and perceptions regarding Education in Egypt further hinder the application of ESD pedagogies. To conclude, EDU 2.0 does include elements of ESD and opportunities to deliver the new curricula through ESD Pedagogies, presented in this study by the Science Techbook of Primary Four. However, “Integration” is not yet achieved due to the challenges discussed (see section 5.2.1). Education reform is a long process, and a longer time is needed to evaluate the impact of the changes made so far on the different stakeholders involved with students being of utmost importance, but, by and large, the way to development lies in the teacher at the heart of any reform being the change agent, following the bottom-up approach of development that is crucial to go hand in hand with the top-down approach. In my personal opinion, in the context of Egypt, the bottom-up approach is a more effective way to change, and this is how and why it all starts and ends with the teachers.

5.4. Recommendations

Regarding recommendations for the curriculum, several key points have been identified. Firstly, there is a concern that the content is excessively big, thus overwhelming students and teachers. Maybe modifications to decrease the amount of content to allow more room for conducting activities might help fulfill the objectives of the curriculum better. Secondly, the pacing recommendations provided may not

align with practical classroom realities, requiring a reassessment to ensure they are more feasible. Thirdly, it's proposed that projects be allocated at the beginning of the units to be utilized as a learning approach rather than just for application at the end of the unit.

As for teachers-related challenges, there's a need to revisit and enhance the Professional Development plan, ensuring teachers are adequately prepared and supported, and implementing an incentivization plan could also serve to motivate and engage teachers in the effective delivery of the curriculum. Educational Policies related to teachers' recruitment, appraisal, and retention cannot be overlooked and further research is needed to address these issues, with teachers' status and satisfaction as the leading theme, considering their inclusion in the reviewing and planning for changes, and considering their workload and mental health and well-being. The challenges related to the learning environment presented in the physical status of public schools, and the class size are to be addressed in parallel with the reform taking place in the system, to facilitate its implementation.

Finally, the beliefs of Egyptians and their perceptions of education need to be taken into consideration and addressed at a national level. Parents, specifically mothers, as stated by Dr. Tarek, need to be educated on what quality education is. This cannot be the sole role of one ministry, but the collective effort of the different institutions to raise this awareness, specifically through the Media.

5.5. Future Research

In identifying areas for future research, several key topics emerge that hold significance for deepening our understanding and informing educational practice, with the issues related to teachers being at the forefront of investigation, based on the notion that they are the key players in the success of the education system. Firstly, research into Professional Development (PD) is crucial for understanding its design and impact on teacher practice and student outcomes. Exploring effective PD models and their implementation can provide valuable insights into enhancing teaching quality and educational outcomes. Secondly, examining the perception of teachers towards educational policies is essential for promoting

teacher self-motivation. Investigating the role of policies in shaping teachers' attitudes, motivation, and professional development can inform the design and implementation of effective policies that support teacher well-being and effectiveness. Thirdly, understanding the conditions that influence teachers' experiences, including factors such as salaries, appraisal policies, and support mechanisms, is vital for addressing teacher satisfaction. Research in this area can provide evidence-based recommendations for improving teacher working conditions and enhancing overall educational quality. Furthermore, bridging the gap between teachers' practice and policymaking is essential for effective educational reform. Exploring strategies to reduce this gap, such as fostering collaboration between practitioners and policymakers, can lead to more responsive and impactful education policies. Lastly, investigating the culture of parents and their perceptions of quality education is crucial for promoting effective home-school partnerships and enhancing student outcomes. Understanding the factors that influence parental perceptions and strategies for promoting positive parental engagement can contribute to building stronger school communities and improving educational outcomes for all students.

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Appendix A

The Rubric of Analysis of the K/S/V of the Learning Objectives (Osman et.al,2017)

Goal 1 –No Poverty (G1.)
Knowledge and understanding
K.1.Explore the complex issues of poverty to understand the interconnected world we live in
K.2. Concept of poverty, from an individual understanding within local context to a global perspective examining the extent of poverty in Commonwealth countries
K.3.Differences in economic, demographic and social characteristics between countries across the world
K.4.Causes of global poverty and inequality
K.5.Conditions of poverty due to lack of food, poor sanitation and other losses of services
K.6.Learning about the different concepts of poverty, and what life is like for people living in poverty
Skills and applications
S.1.Application of critical thinking for analysis of poverty and related issues through simulations, discussions, challenging assumptions, developing supporting arguments, and sharing and evaluating information, experiences and opinions
S.2.Learning supported by teamwork and co-operation, discussion and reflection, and the application of different methods (e.g. statistical analysis and persuasive writing) to examine and interpret poverty in the world around them
S.3.Understand the possibility of change and develop actions that support this change
S.4.Development of basic financial literacy skills

Values and attitudes
V.1.Awareness of the multiple causes of poverty
V.2.Qualities of empathy and understanding, sensitivity to the issues of poverty and inequalities, identification of personal biases regarding poverty, and acceptance of differences
V.3.Recognize people's common humanity and what can be learnt from others
V.4.Willingness to explore solutions and confidence that extreme poverty can be overcome in the learner's own lifetime
V.5.Action-oriented in furthering awareness
V.6.Placing value on education and financial management

Goal 2-Zero Hunger (G2.)
Knowledge and understanding
K.1.Nutrition education that combines classroom learning with practical learning activities (e.g. growing fruits and vegetables in school gardens, preparing food, planning meals, practicing personal hygiene, improving school meals and keeping a clean safe school environment)
K.2.Gardening activities, combined with eating the foods produced and learning about healthy dietary practices
K.3.Defining hunger and malnutrition
K.4.Explore the definition and problems of hunger, malnutrition and food insecurity
K.5.Food security, livelihood and gender inequality
K.6.Where different foods come from: fruits, vegetables, dairy, meat Follow food from the farm to the pot
K.7.Storing food: fresh, tinned, dried, frozen
Skills and applications

S.1.Distinguish between food groups and types of food to eat and why, and establish a balanced diet. Create mindful eating plan and commit to making changes in personal eating and buying habits
S.2.Ability to read labels and ingredient lists, and how to interpret health claims
S.3.Identify and access healthy alternatives to fast food
S.4.Apply healthy eating concepts to avoid food-related illnesses e.g. obesity or diabetes, including ability to distinguish between portion and serving size
Values and attitudes
V.1.Adopt healthy lifestyles and mindful eating habits beyond school and into adulthood
V.2.Willingness to find solutions to food insecurity and malnutrition
V.3.Appreciate indigenous or local perspectives on ways of living together and using resources sustainably
V.4.See every individual as a powerful agent of change to sustain the food system
V.5.Share learning with friends, family and community
V.6.Positive attitudes and skills that pave the way for carrying healthy habits beyond school

and into adulthood
V.7.Taking responsibility for personal health
Goal 3- Good health and well-being (G3.)
Knowledge and understanding
K.1.Learning to address personal and food hygiene and sanitation, and disease and infection transmission/control
K.2.Understanding healthy eating and nutrition

K.3.Engage in various activities for health, fun, and development of motor skills
K.4.Physical literacy to establish a basis for lifelong physical activity and active living
K.5.Learning about pressures and harmful behaviors, and ways to resist them
K.6.Emergency preparedness, evacuation drills, first aid
K.7.Pedestrian and cycling safety
K.8.Basic understanding of physical and mental health conditions and disabilities, risk factors, etc., including non-communicable diseases
K.9.Antiviolence and bullying prevention
K.10.Learning about mental and emotional health, and sexual and reproductive health and rights
Skills and applications
S.1.Application of understanding to real life, such as personal hygiene and sanitation, and healthy living (e.g. food choices and exercise)
S.2.Ability to communicate healthy living practices to family and community
S.3.Ability to access information for informed decision making and application for positive and healthy behaviors (e.g. in relation to sexual and reproductive health, food and hygiene choices, participation in sport)
S.4.Ability to identify positive and negative influences, analyses risks, and make informed decisions
S.5.Coping, social and cognitive skills in managing personal health and well-being

S.6.Ability to express feelings in a healthy way, use self-control and impulse control, manage emotional and physical stress, and seek assistance if necessary
Values and attitudes
V.1.Responsibility for personal health and well-being, placing value on personal hygiene and sanitation, good nutrition, physical activity, and reducing risks to physical and mental health
V.2.Establishment of positive eating and fitness habits
V.3.Empowerment to take action and recognizing the ability to promote understanding and healthy practices to others
V.4.Positive attitudes toward self, and acceptance of responsibility for personal sexuality
V.5.Independent decision making that analyses health and well-being influences and risks, and respects human rights (e.g. resisting peer pressure in bullying)
V.6.Tolerance, respect and understanding of others' differences and emotions
Goal 4- Quality education (G4.)
Knowledge and understanding
K.1.My right to schooling
K.2.My responsibility to work hard
K.3.Why learning is important in my life

K.4.What I want to be when I leave school
K.5.Education in other parts of the world
K.6.Introduction to the SDGs as a set of targets with the aim of ending extreme poverty for everyone and tackling climate change
Skills and applications
S.1.Demonstrate appropriate schooling behaviors
S.2.Identify own learning needs for personal development
S.3.Make connections between own lives and those of others throughout the world
S.4.Learning to learn
S.5.Critical and engaged approach towards learning
Values and attitudes
V.1.Self-disciplined, self-reliant and integrated citizen
V.2.Values of gratitude and appreciation
V.3.Rights and responsibilities
V.4.Valuing quality education for all
V.5.Appreciate access to education
V.6.Empathy with children who do not have access to schooling
V.7.Appreciation and respect for diversity
Goal 5- Gender equality(G5.)
Knowledge and understanding

K.1.Gender roles as social constructs
K.2.Distinguish between biological sex, gender identity and gender expression
K.3.Separate adjectives, jobs, domestic duties and childcare responsibilities into female, male and gender-neutral sets
K.4.The impact of gender roles on the identity and rights of girls and boys
K.5.Meaning of the terms ‘rights’ and ‘equality’
K.6.Learn from case studies from different Commonwealth countries
Skills and applications
S.1.Analyze how gender affects everyday lives and devise solutions for any challenges
S.2.Take equal responsibility in classrooms and school activities
S.3.Analyze basic information on gender inequality worldwide
S.4.Analyze norms that hamper gender inequality
S.5.Think critically about socially ascribed gender roles and stereotypes in jobs, sports and the family
S.6.Identify issues of gender inequality in the school or community on which pupils could take action
S.7.Develop positive notions of gender

Values and attitudes
V.1.Girls and boys respect each other
V.2.Advocate for a harassment-free school or learning environment
V.3.Shared responsibility between boys and girls in classrooms and school activities
V.4.Girls and boys participate in extracurricular activities
V.5.Awareness of cultural practices that affect girls' and women's rights in society
V.6.Gender equality and empowered women and girls
V.7.Degendered understanding of professions, sports and family roles
V.8.Exercise later in life, active citizenship and claim rights relating to gender equality
Goal 6-Clean water and sanitation (G6.)
Knowledge and understanding
K.1.Use of water in domestic activities for cleanliness, hygiene, relaxation and food preparation, and formation of daily habits, routines and lifestyles
K.2.Deconstructing the routines, habits and lifestyles in which water plays a part, and the influence of peers, family and social norms on water use
K.3.Principle of water abundance v. water scarcity, both physical and economic, and as a finite resource
K.4.Potential effects of dirty water: poor health, increased hunger, poverty and lack of access to education
K.5.Water resources and utilization by humans (agriculture, industrial, domestic,

recreational, fisheries)
K.6.Safe disposal of wastewater, human excreta, solid waste
K.7.Household sanitation and food hygiene
K.8.Basic understanding of water science –hydrology, the hydrologic cycle and connection to climate change
Skills and applications
S.1.Understanding and conscious water consumption
S.2.Understanding of water-related issues for behavioral changes
S.3.Understanding of water scarcity and abundance
S.4.Conceptualizing water flowing through landscape scale systems
S.5.Apply understanding of the structure of watershed to explain the movement of water and other substances
S.6.Ability to interpret common representations, such as maps of waterways
S.7.Safe handling of drinking water
S.8.Understanding how water moves through environmental systems, interacts with other substances, dissolves and moves certain substances underground

Values and attitudes
V.1.Responsible and sustainable consumption
V.2. Motivation to change patterns of unsustainable consumption
V.3. Understand appropriate personal hygiene; washing hands, brushing teeth. etc.
V.4.Safe use of toilets and urinals ,including cleansing and washing
V.5.Responsible and sustainable consumption
V.6.Motivation to change patterns of unsustainable consumption
V.7.Link collection and treatment of solid waste with overall health risks
V.9.Sensitized to the ways that water is borrowed from and returned to nature through human activities
V.10.Making informed decisions about water at an individual or societal level

V.11.Participate in community decisions about how to manage landfills
Goal 7-Affordable and clean energy (G7.)
Knowledge and understanding
K.1.Basic concepts of energy and consumptive uses (e.g. powering cars)
K.2.Different forms of energy production (e.g. fossil fuels, wind energy, etc.), associated technologies, and why different forms of energy production are best used in different geographies and contexts
K.3.Introduction to the concept of global warming and how it links to human energy production and consumption
Skills and applications
S.1.Act as an energy monitor (including in the classroom)
S.2.Identification and practice of actions and choices for sustainable and safe living
S.3.Uses of alternative energy at home, school and in the wider community (e.g. solar energy for cooking and heating)
S.4.Application of simple calculations and analysis of different energy choices and uses (e.g. efficiency and cost analysis)

Values and attitudes
V.1.Environmentally sound ethics
V.2.Commitment to energy conservation
V.3.Daily living habits and behaviors for sustainable living
V.4.Consumptive behavioral change
V.5.Reuse items such as plastic bags, glass jars, plastic containers, envelopes and paper
Goal 8-Decenth work and economic growth (G8.)
Knowledge and understanding
K.1.Job classifications
K.2.Jobs in the school, community, etc.

K.3.People who care
K.4.Why people work
K.5.Work, employment, unemployment, self-employment and enterprise
K.6.Social enterprise
K.7.The SDGs
K.8.What it means to combat inequality
Skills and applications
S.1.Explain the different kinds of jobs in other parts of the world
S.2.Exploring solutions for inequality
S.3.Access and opportunity for all
S.4.Holding meetings, budgeting, making rules and selling products through role play
Values and attitudes
V.1.Appreciation of the multifaceted nature of the world/surroundings
V.2.Value/appreciate the resources and services available
V.3.Gratitude
V.4.Finding positive solutions
V.5.Learn to value the different forms of work including paid work, unpaid care work, voluntary work and creative expression
Goal 9-Industry, innovation and infrastructure (G9.)
Knowledge and understanding

K.1.Understanding of different types of infrastructure and their uses (e.g. transport, energy, utilities)
K.2.Concepts of sustainability, industry, economic development, human well-being
K.3.Understanding the economic, environmental and social benefits and challenges of different types of infrastructure and industry
K.4.Hard (e.g. roadways, buildings) and soft infrastructure (e.g. financial systems, hospitals, schools)
K.5.Computer literacy
Skills and applications
S.1.Ability to identify different community places and their purposes
S.2.Ability to identify different sources of energy used in communities
S.3.Understanding that sources of energy are not sustainable
S.4.Computer skills for research, word processing, etc.
S.5.Information management
S.6.Ability to analyses the benefits and drawbacks of different forms of infrastructure and industry

Values and attitudes
V.1.Focus on sustainability
V.2.Inquisitive
V.3.Value well-being and economic resilience
V.4.Affordable and equitable access for all
V.5.Willingness to explore
V.6.Use of experiences to understand theories
V.7.Appreciation for provision of public services
Goal 10- Reduced inequalities (G10.)
Knowledge and understanding
K.1.Basic understanding of fairness and equality in the world (e.g. through sport and games as relatable examples)
K.2.Links between education and inequality – education as both a factor that conditions inequalities later in life (e.g. access to formal jobs) and a powerful instrument for advancing

equity, and impact on income
K.3.Unpacking stereotypes regarding gender, religion and race
K.4.Ratios using inequality statistics, e.g. the number of disabled people in work compared with non-disabled people, or the number of women on boards compared with men
Skills and applications
S.1.Application of knowledge to reflect on and analyze real world issues (e.g. factors that may affect a country's participation/success in an Olympic sport
S.2.Express views on why a particular inequality is bad and develop solutions for changing the situation
S.3.Analyze issues affecting the lives of people in local and global contexts
Values and attitudes
V.1.Respect for others and diversity
V.2.Empathies with people's situations
V.3.Value of education as a tool for progress and empowerment
V.4.Willingness to take action and advocate equal access to education globally

V.5.Empathy and tolerance
V.6.Appreciate the feelings of people involved in negative experiences
Goal 11- Sustainable cities and communities (G11.)
Knowledge and understanding
K.1.The nature and components of cities and our basic needs: food, housing, energy, transport and water
K.2.Understanding of warnings and disaster preparedness
K.3.Ways in which green spaces and nature are integrated in the community

K.4.Participatory design of city parks, playgrounds, large-scale public spaces, open spaces
K.5.Local ecosystems and accessible examples of sustainable lifestyles
K.6.Investigation of the urban environment, urban design and planning
K.7.Urban environmental education
K.8.DRR (Disaster Risk Reduction) and management
Skills and applications
S.1.Ability to care for parts of cities and human settlements (e.g. starting a community vegetable garden)
S.2.Collaborative learning and engagement
S.3.Multicultural nature of cities/towns
S.4.Innovations for urban environments
S.5.Disaster preparedness
Values and attitudes
V.1.Awareness of the importance of sustaining the natural environment
V.2.Creative self-expression
V.3.Application of diversity
V.4.Environmental consciousness
V.5.Appreciation of safe spaces and security
Goal 12-Responsible consumption and production (G12.)
Knowledge and understanding

K.1.Sustainable and unsustainable consumption, including resource use, waste generation and disposal, and environmental and health impacts
K.2.Further understanding of the ‘4 Rs’
K.3.Identify examples or irresponsible and unsustainable consumption and production both locally and globally
K.4.Understand impact of consumptive choices (e.g. diet)
K.5.Participatory learning
K.6.Explore how technology can be harnessed and used to support responsible consumption and production
K.7.Calculate and compare Ecological Footprints
Skills and applications
S.1.Distinguishing between and analyzing consumer impacts and risks of different choices (e.g. discovering what products are made of, decomposition times, where waste goes)
S.2.Participating in recycling, composting and other environmental schemes
S.3.Analyze carbon and methane impacts of diet and food purchasing behavior
S.4.Food chain analysis (e.g. family food purchasing behavior and impacts)

S.5.Understand the challenges facing the planet and the need for more responsible consumption and production patterns
S.6.Understand how fast resources are consumed and waste is generated
Values and attitudes
V.1.Appreciation of the need to reduce harm, of impact and of finite resources
V.2.Adoption of non-wasteful behaviors (e.g. reduce packaging, use compost, seek environmentally friendly options)
V.3.Awareness of environmental/health risks, and benefits of safe disposal
V.4.Informed purchasing (product lifecycle implications)
V.5.Consumer awareness and commitment to sustainable choices
V.6.Prepared to take action to bring about change and reduce the Ecological Footprints
Goal 13- Climate action (G13.)
Knowledge and understanding
K.1.Understanding of and preparedness for natural disasters (e.g. floods, tsunamis, earthquakes)
K.2.Basic understanding of climate science (e.g. carbon cycles, greenhouse gas effects) and physical impacts (e.g. sea-level rise, extreme weather)
K.3.Foundation in economic, environmental and social concepts of climate change, and how it relates to human lives (e.g. health, energy, food production)
K.4.Exploration of traditional/indigenous knowledge and culture
K.5.Concepts of climate mitigation and adaptation, resilience, sustainable development

Skills and applications
S.1.Natural-disaster preparedness
S.2.Ability to describe the causes and effects of climate change
S.3.Understand and distinguish climate change impact in relation to self/context
S.4.Analyze impacts and vulnerability in key sectors due to climate change
S.5.Impact analysis (e.g. interpret maps, graphs and statistics) across spatial and temporal scales
S.6. Understanding issues of equity and climate justice
S.7.Differentiate between adaptation and mitigation measures, and employ creative solution-finding skills
Values and attitudes
V.1.Awareness of the impacts of human activities and consequences of personal actions
V.2.Concern for and responsibility for living organisms and their environment
V.3.Motivation to make informed decisions and take responsible action
V.4.Awareness of different impacts (e.g. geographic, socio-economic)
V.5.Global citizenship

V.6.Appreciation of traditional cultures
Goal 14-Life below water (G14.)
Knowledge and understanding
K.1.Introduction to understanding the role of the ocean (e.g. moderating climate, providing oxygen and food, medicine, energy and minerals)
K.2.Introduction to ocean zones, and marine plants and animals, their habitats and behaviors
K.3.Knowledge of ocean animals and adaptation
K.4.Introduction to recognizing the global context of challenges for local fisheries and how this affects fishermen's livelihoods
Skills and applications
S.1.Application of critical thinking skills to investigate threatened or endangered species, and conducting surveys or interviews with fishermen and fish processors to develop potential solutions to the challenges faced
S.2.Application of concepts to investigate how ocean animals adapt to certain parts of their environment to develop potential solutions on how to protect oceans
Values and attitudes
V.1.Awareness and appreciation of, and respect for, the environment and nature, oceans and marine life, their fruitfulness and the need to care for these resources
V.2.Show concern and responsibility for living organisms and their environment, including endangered species
V.3.Awareness and behavioral change towards more sustainable practices during daily life

Goal 15- Life on land (G15.)
Knowledge and understanding
K.1.Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health and consequences of human impact
K.2.Understand the importance of biodiversity and threats to biodiversity, habitat loss; concept of endangered species
Skills and applications
S.1.Ability to communicate the importance of terrestrial ecosystems
S.2.Analyze impacts and risks associated with biodiversity loss and ecosystem degradation
S.3.Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)
Values and attitudes
V.1.Appreciation for the need to conserve biodiversity
V.2.Basic understanding of rights of other species, and valuing the interdependence of species

Goal 16- Peace, justice and strong institutions (G16.)
Knowledge and understanding
K.1.Linking to the expressive arts, pupils develop imaginative and creative ways of expressing some of their own commitments, including working hard at sport or music, caring for animals and the environment, loving their family or serving God
K.2.Diversity of national and international religious and ethnic identities; the need for mutual respect and understanding at global level
K.3. Religious and cultural literacy
Skills and applications
S.1.Skills of enquiry: contribution to discussions and debates
S.2.Ability to challenge injustice and inequality
S.3.Learn to weigh up the value of wisdom from different sources, to develop and express insights in response, and to agree or disagree respectfully
S.4.Application of critical thinking skills to describe, explain and analyze beliefs, practices

and different ways of life
S.5.Research and evaluation of global issues related to religion, culture, identity and peace
Values and attitudes
V.1.Appreciation of experiences of others
V.2.Value co-operation
V.3.Empathy and open-mindedness
V.4.Sense of identity and self-esteem
V.5.Belief that people can make a difference
V.6.Participation in society and civic responsibility
V.7.Confidence in beliefs and values, respect for religious and cultural differences, and willingness to contribute to a cohesive and compassionate society
V.8.Appreciate the significance and impact of different ways of life
V.9.Value justice, freedom, equality and well-being
Goal 17- Partnerships for the goals (G17.)

Knowledge and understanding
K.1.Creative collaboration to work in teams to design a mini-project to support better partnerships later in life
Skills and applications
S.1.Critical thinking, analytical enquiry, numerical skills, basic statistical analysis
S.2.Arguing a viewpoint other than one's own
S.3.Communicating ideas, listening to others, working with others to solve problems
S.4.Team building and negotiation skills
Values and attitudes

V.1.Empathizing with others. Advocating policy change at local and/or national level, and taking informed and responsible action
V.2.Personal, social and emotional development. Children understand that they can expect respect; work as part of a group, taking turns and sharing fairly, and understand that groups of people, including adults and children, need values and codes of behavior to work together harmoniously
V.3.Show sensitivity to others' needs and feelings
(Source: Osman et. al, 2017) **K:** Knowledge and understanding **S:** Skills and applications **V:** Value and attitudes

Appendix B

Interview Questions

Questions for Science Teachers Interviews

1. For how long have you been teaching this curriculum?
2. What do you use for preparing lessons ?
3. Do you use the techbook?
4. What kind of professional development (PD) have you undertaken to teach this curriculum? How frequent ?
5. What do you know about Sustainable Development Goals?

6. Have you ever received any PD to integrate Education for Sustainable Development?
7. What PD did you take specifically for teaching this curriculum by the school or the MOE ?
8. What set of skills do you think are the top 3 (or more) that this curriculum delivers ?
9. What are your most used pedagogies to teach this curriculum?
10. Is there a specific number of projects to do per unit / per term ?
11. Tell me about the projects/projects that you conducted with your students to apply a certain concept.
12. What challenges have you experienced in delivering this curriculum?
13. What aspects do you need to support your teaching for this curriculum?

Questions for Curriculum Experts

1. Can you walk me through the process of developing the Primary 4 science curriculum? What were some of the key considerations during its development?

2. In your opinion, what were the main goals or objectives you aimed to achieve with the primary 4 science curriculum?

3. Were there any specific themes or values that were prioritized in the development of the curriculum?

4. How did you ensure that the Primary 4 science curriculum remained relevant and engaging for students?

5. Can you discuss any challenges or obstacles you encountered during the development phase of the curriculum?

6. Were there any particular sources of inspiration or models you drew upon when designing the primary 4 science curriculum?

7. In hindsight, is there anything you would have done differently during the curriculum development process?

8. What kind of feedback or input did you receive from educators, experts, or stakeholders during the development of the curriculum?

9. How did you go about integrating different subject areas or disciplines within the primary 4 science curriculum?

10. Can you describe any specific strategies or approaches you used to promote critical thinking and problem-solving skills within the curriculum?

11. Were there any considerations given to real-world applications or contexts within the primary 4 science curriculum?

12. How did you address the diversity of learners' backgrounds and experiences within the curriculum?

13. Can you discuss any efforts made to promote environmental awareness or stewardship within the primary 4 science curriculum?

14. What role do you see science education playing in shaping students' understanding of their role in society and the environment?

15. Looking forward, how do you envision the Primary 4 science curriculum evolving or adapting to meet the changing needs of students and society?

Questions for Dr. Tarek Shawki's Interview

1. What were the main drivers for the project of Edu 2.0?

2. What were the main objectives or goals that guided the development of the curricula under this project?

3. How did the curriculum align with broader educational policies or initiatives at the national or regional level?

4. Were there any specific challenges or obstacles encountered during the development phase, and how were they addressed?

5. What was the role of stakeholders or partners in shaping the curriculum during its development? Was there a specific rationale for choosing these partners?

6. Is there anything that could have been done differently during the development process of the curriculum?

7. What mechanisms were in place to monitor and evaluate the effectiveness of the curriculum in practice?

8. What feedback channels were utilized to gather input from educators, students, and other stakeholders during the implementation phase? What is the process of considering the feedback for further developments of the curricula?

9. What were the notable successes or challenges encountered during the application of the curriculum in its initial phases?

10. How was professional development and support provided to teachers to facilitate the effective implementation of the curriculum?

11. Can you discuss any evidence or data indicating the effectiveness of the primary 4 science curriculum in achieving its intended goals?

12. Can you discuss any plans or strategies for further improving or evolving the curriculum based on its impact thus far?

13. Were there any unexpected outcomes or lessons learned from the implementation of the primary 4 science curriculum?

14. What are your expectations for how the project will continue?

Appendix C

Rubrics Templated for the Content Analysis

Step 1- SDGs X Concepts

Unit (Theme)	**Concept**	**Related SDG**	**Environmental**	**Social**	**Economic**
1-					
2-					

Step 2- Learning Indicator x KSV

Learning Indicator	**Knowledge**	**Skills**	**Values**

Step 3- Learning Activities X ESD Competencies

Theme:

Concept:

Mapped SDG:

Learning Activity	Knowledge of SDG/s	Skills						Values	
		Ways of Thinking			Ways of Practicing				
		ST	CT	AT	SC	CC	IPS	SAC	NC

Appendix D

IRB Approval Letter

THE AMERICAN UNIVERSITY IN CAIRO
INSTITUTIONAL REVIEW BOARD

Case# 2023-2024-124

To: Aya Elkholy
Heba Eldeghaidy
Nadia Fouad

From: **Heba Kotb**
Chair of the IRB
Date 13/2/2024

Re: IRB approval

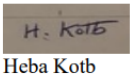
This is to inform you that I reviewed your revised research proposal entitled

"A Qualitative Analysis of the Integration of ESD Competencies in an Egyptian Science Curriculum"

It required consultation with the IRB under the "expedited" category. As you are aware, there were minor revisions to the original proposal, but your new version addresses these concerns successfully, your proposal used appropriate procedures to minimize risks to human subjects and that adequate provision was made for confidentiality and data anonymity of participantsin any published record. I believe you will also make adequate provision for obtaining informed consent of the participants. This approval letter was issued under the assumption that you have not started data collection for your research project. Any data collected before receiving this letter could not be used since this is a violation of the IRB policy.

Please note that IRB approval does not automatically ensure approval by CAPMAS, an Egyptian government agency responsible for approving some types of off-campus research. CAPMAS issues are handled at AUC by the office of the University Counsellor. The IRB is not in a position to offer any opinion on CAPMAS issues, and takes no responsibility for obtaining CAPMAS approval.
This approval is valid for only one year. In case you have not finished data collection within a year, you need to apply for an extension.

Thank you and good luck.



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