What Learning Opportunities does the Chilean Primary Education Curriculum Offer to Train in Sustainability?

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Abstract: Education is a fundamental tool to make a country's society equitable, just, and respectful of the environment. As primary education is compulsory for a country's population, it allows building knowledge and skills to promote sustainable development, in this sense, it is necessary to examine whether the primary education curricular bases offer learning opportunities and contexts for students at this stage to develop their awareness, knowledge and skills in a sustainable way. The qualitative methodology was used, specifically, the content analysis to analyze the 24 Chilean primary programs of Mathematics, Natural Sciences and Social Sciences under the cognitive domain of Education for sustainable development *(ESD) and in terms of their learning objectives with the* sustainability development goals *(SDGs). The results show that an interdisciplinary stochastic education in the context of the curricular learning of Social Sciences and Natural Sciences provides learning opportunities to develop ESD at the different levels that make up primary education. It is observed that the Natural Sciences and Social Sciences curricula at all levels of primary education lead to ESD are being developed in an interdisciplinary manner (with these two subjects and stochastic themes).*

INTRODUCTION

On September 25, 2015, the United Nations General Assembly proposes the 2030 Agenda to take on the challenge of the 17 Sustainable Development Goals (UNESCO, 2015). These SDGs incorporate the social, economic and environmental needs that have afflicted our planet for several decades. Thus, through the 2030 agenda, UNESCO intended to respond to various situations that in one way or another have an impact on sustainable development, such as inequality, hunger, diseases, unsustainable consumption, and environmental degradation (UNESCO, 2017).

Today, nine years from the deadline, even in the context of a pandemic, it is clear that we are far from being able to achieve the challenges and objectives of the 2030 agenda. Facing the crisis, many of the countries have adopted safeguard measures related to the suspension of

face-to-face classes (ECLAC, 2020), which has generated negative impacts on educational results, making promotion of quality education described by goal 4.7 of SDG 4: "to guarantee that all students acquire theoretical and practical knowledge necessary for sustainable development" (UNESCO, 2017, p.7) difficult. In this sense, for all citizens to have the knowledge, skills and abilities that allow them to act as agents of change capable of contributing to sustainable development (UNESCO, 2017; De la Rosa, Giménez & Calle 2019), it is essential that all countries promote ESD, incorporating it into the curricula at all educational levels (Eriksen, 2013; UNESCO, 2015; Richter et al., 2017; Bascopé et al., 2019).

In this sense, ESD is a goal of quality education, whose transversal nature allows each SDG to be approached from different subjects, thus training reflective and conscious students (Hedefalk et al., 2015), capable of making decisions and leading their actions towards sustainable development.

However, different authors (Sleurs, 2008; Cebrián & Junyent, 2014; Albareda-Tiana et al., 2019; De la Rosa et al., 2019) suggest that some of the domains that should be considered while implementing ESD in the classroom are: a) knowledge (related to social, economic and environmental issues); b) contextualization (upon meaningful, understandable and education level-linked information to the students); and c) integration (articulating knowledge from various disciplines in ESD).

Considering the above, some proposals have been observed recently to link ESD with mathematics education, and in particular, with statistical and probabilistic education based on citizen literacy in statistics and probability (Vásquez, 2020; Vásquez & García-Alonso, 2020), assuming the premise that its contextual character (Batanero, 2013), great potential to address problematic situations in sustainability contexts (Vásquez, 2020; Vásquez & García-Alonso, 2020; Eernstman & Wals, 2013) and delivery of cognitive tools to make correct decision in a random situation (Batanero, 2004) will facilitate the acquisition of knowledge to promote sustainable development (Bascopé et al. 2019; Ramadhani et al., 2022).

Primary education builds the basic education of the values, attitudes, skills and knowledge of Chilean students from 6 to 14 years old. As statistics and probability are incorporated as topics within the school-year Mathematics study programs (Batanero, 2004), therefore, stochastic education is currently established within mathematics education (Batanero, 2019). Consequently, we use the term stochastic education to name statistical and probabilistic education "to emphasize the mutual dependence of knowledge and reasoning about probability and statistics, which are interconnected and must be taught together" (Batanero, 2019, p. 2). On the other hand,

> "the concept of sustainable development and the treatment of problems related to understanding and caring for the environment are part of the curricular bases, of the

> Transversal Fundamental Objectives and, specifically, of the curriculum of the History and Social Sciences and Natural Sciences at all levels and modalities of the system" (MMA, 2012, p. 9).

Therefore, this study analyzes the Chilean primary education curriculum (MINEDUC, 2018) in order to identify links between stochastic education (specifically, the axis of Data and Probabilities within the mathematics plans) and the thematic contents of the area of Natural Sciences and History, Geography and Social Sciences (hereinafter Social Sciences). With this, it is expected to contribute with useful information for the design of statistical and probabilistic tasks in identified contexts of the aforementioned study areas with a focus on sustainability.

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Internationally, ESD is recognized as an important global agreement. It was discussed at the three world summits on sustainable development: the United Nations Conference on Environment and Development (UNCED) in 1992, in Rio de Janeiro; the World Summit on Sustainable Development (WSSD) in 2002, in Johannesburg; and the United Nations Conference on Sustainable Development (UNCSD) in 2012, in Rio de Janeiro. Thus, the United Nations Decade of Education for Sustainable Development (DESD) (2005-2014) aimed to integrate the principles and practices of sustainable development in all aspects of education and learning to promote changes in knowledge, values and attitudes in order to allow a more sustainable and just society for all. The Global Action Program on ESD, endorsed by the 37th Session of the UNESCO General Conference, seeks to expand ESD on the basis of the achievements of the Decade. Although progress has been made in terms of sustainable development, sustainability has not been achieved globally (UNESCO, 2015). For this reason, in 2012, the Rio +20 Conference on Sustainable Development took up the issue, proposing to create a work team to establish guidelines and provide a sustainable solution to situations that imply risk in the lives of people and the planet in the future. The following year, the 17 SDGs (Table 1) that propose 169 targets (UNESCO, 2017) and their link with ESD to achieve a better and more sustainable future for all (United Nations, 2019) were presented.

SDGs	Description
1. No poverty	End poverty in all its forms everywhere
2. No hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
3. Good health	Ensure healthy lives and promote well-being for all at all ages
4. Quality education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5. Gender equality	Achieve gender equality and empower all women and girls
6. Clean water and sanitation	Ensure availability and sustainable management of water and sanitation for all
7. Renewable energy	Ensure access to affordable, reliable, sustainable and modern energy for all
8. Good jobs and economic growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Innovation and infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
10. Reduce inequalities	Reduce income inequality within and among countries
11. Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient, and sustainable
12. Responsible consumption	Ensure sustainable consumption and production patterns
13. Climate action	Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy
14. Life below water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Life on land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Peace and justice	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Partnerships for the goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Table 1: Description of the 17 Sustainable Development Goals (UNESCO, 2017, p. 6)

Currently, we live in the information age, in which it is essential that citizens have the necessary knowledge to critically evaluate information in various contexts to give opinions based on the data that arise from the problems of the daily life (Vallecillos & Batanero 1997; Batanero, 2000; Gal, 2002; Vásquez, 2020; Vásquez, García-Alonso, 2020). For this, according to Horton and Hardin (2015), it is important that individuals increase their problem-solving skills using data in context. However, local, regional and global situations impact differently on economic, social and environmental aspects (Engel, 2017). In addition to being complex and uncertain, these situations can hardly be resolved through the basic problem-solving processes based on a single strategy, which is the traditional way taught at school, but through sustainable solutions that originate from a collaborative work among sustainable citizens, who are active, transformative, and capable of thinking critically and applying sustainability competencies in search of a sustainable society (Hedefalk et al., 2015; Quelhas et al.,2019; Mumu et al., 2021).

ESD is inherent to the criterion of lifelong learning, so it can be implemented in formal education (Eernstman & Wals, 2013) and at all educational levels, that is, from Early

Childhood Education to Higher Education (Vare & Scott, 2007). In addition, ESD is holistic and transformative, which not only integrates sustainable content within the curricula, but also creates interactive and student-centered teaching and learning contexts. In this sense, an action-oriented education is needed, emphasizing aspects such as self-taught learning, participation and collaboration, orientation towards problems, interdisciplinarity (Bascopé et al., 2019), and creating links between formal and informal learning. Likewise, it must be an education capable of intensively addressing the different themes involved in the SDGs, allowing students to develop the competencies of sustainability. To this end, UNESCO (2017) proposes the need to address a set of key sustainability competencies that are transversal to the 17 SDGs (Figure 1).

Figure 1: Relationship between key sustainability competencies and the SDGs. (Vásquez, 2020)

1) Systems thinking competence: skills to identify, analyze and deal with complex and uncertain relationships and situations in different systems.

2) Anticipation competence: skills to evaluate multiple possible, probable and desirable future scenarios that allows students to deal with the consequences of actions, risks and changes.

3) Normative competence: skills to understand the rules of the underlying actions to negotiate in a context of conflicts of interest that allows to develop the values, principles, objectives and goals of sustainability.

4) Strategic competence: skills to collectively develop and implement innovative actions that promote sustainability in context.

5) Collaborative competence: skills to exercise empathy and empathic leadership to facilitate collaborative and participatory problem solving.

6) Critical thinking competence: ability to question one's own values, norms, practices, opinions and actions to adopt a position of sustainability.

7) Self-awareness competence: ability to reflect on the role that each one has in the local community and in society.

8) Integrated problem-solving competence: general ability to apply the aforementioned competencies in different settings to give equitable and sustainable problem solving.

These competencies are transversal, multifunctional and independent of the context, and empower individuals to link them with the learning objectives involved in the different SDGs.

Since the SDGs are defined from the cognitive (knowledge and thinking required to understand the specific SDG and the challenges involved to achieve it), socio-emotional (includes social skills such as values, attitudes, and self-reflection to promote SDG) and behavioral (describes the action competencies to achieve each SDG) domains, it is possible to link the learning objectives (LOs) to the SDGs of the subjects that are being taught in primary education. Since the LOs

> "are objectives that define the expected terminal learning of a given subject for each school year. The Learning Objectives refer to skills, attitudes and knowledge that seek to promote the integral development of students. They are organized around the general objectives established by the General Education Law for the field of knowledge and culture" (MINEDUC, 2018, p.24).

Having said that, to show that it is possible to link LOs and SDGs, we portray Table 2 to delineate each SDG from the cognitive domain of EDS.

SDG	Cognitive learning objectives
11	1. The learner understands the concepts of extreme and relative poverty and is able to critically reflect on their underlying cultural and normative assumptions and practices. 2. The learner knows about the local, national and global distribution of extreme poverty and extreme wealth. 3. The learner knows about causes and impacts of poverty such as unequal distribution of resources and power, colonization, conflicts, disasters caused by natural hazards and other climate change-induced impacts, environmental degradation and technological disasters, and the lack of social protection systems and measures. 4. The learner understands how extremes of poverty and extremes of wealth affect basic human rights and needs. 5. The learner knows about poverty reduction strategies and measures and is able to distinguish between deficit-based and strength-based approaches to addressing poverty.
12	1. The learner knows about hunger and malnutrition and their main physical and psychological effects on human life, and about specific vulnerable groups.

	2. The learner knows about the amount and distribution of hunger and malnutrition locally, nationally and globally, currently as well as historically. 3. The learner knows the main drivers and root causes for hunger at the individual, local, national and global level. 4. The learner knows principles of sustainable agriculture and understands the need for legal rights to have land and property as necessary conditions to promote it. 5. The learner understands the need for sustainable agriculture to combat hunger and malnutrition worldwide and knows about other strategies to combat hunger, malnutrition and poor diets.
33	1. The learner knows conceptions of health, hygiene and well-being and can critically reflect on them, including an understanding of the importance of gender in health and well-being. 2. The learner knows facts and figures about the most severe communicable and non-communicable diseases, and the most vulnerable groups and regions concerning illness, disease and premature death. 3. The learner understands the socio-political-economic dimensions of health and well-being and knows about the effects of advertising and about strategies to promote health and well-being. 4. The learner understands the importance of mental health. The learner understands the negative impacts of behaviors like xenophobia, discrimination and bullying on mental health and emotional well-being and how addictions to alcohol, tobacco or other drugs cause harm to health and well-being. 5. The learner knows relevant prevention strategies to foster positive physical and mental health and well-being, including sexual and reproductive health and information as well as early warning and risk reduction.
44	1. The learner understands the important role of education and lifelong learning opportunities for all (formal, non-formal and informal learning) as main drivers of sustainable development, for improving people's lives and in achieving the SDGs. 2. The learner understands education as a public good, a global common good, a fundamental human right and a basis for guaranteeing the realization of other rights. 3. The learner knows about inequality in access to and attainment of education, particularly between girls and boys and in rural areas, and about reasons for a lack of equitable access to quality education and lifelong learning opportunities. 4. The learner understands the important role of culture in achieving sustainability. 5. The learner understands that education can help create a more sustainable, equitable and peaceful world.
55	1. The learner understands the concept of gender, gender equality and gender discrimination and knows about all forms of gender discrimination, violence and inequality (e.g., harmful practices such as female genital mutilation, honor killings and child marriage, unequal employment opportunities and pay, language construction, traditional gender roles, gendered impact of natural hazards) and understands the current and historical causes of gender inequality. 2. The learner understands the basic rights of women and girls, including their right to freedom from exploitation and violence and their reproductive rights. 3. The learner understands levels of gender equality within their own country and culture in comparison to global norms (while respecting cultural sensitivity), including the intersectionality of gender with other social categories such as ability, religion and race. 4. The learner knows the opportunities and benefits provided by full gender equality and participation in legislation and governance, including public budget allocation, the labor market and public and private decision-making. 5. The learner understands the role of education, enabling technology and legislation in empowering and ensuring the full participation of all genders.
66	1. The learner understands water as a fundamental condition of life itself, the importance of water quality and quantity, and the causes, effects and consequences of water pollution and water scarcity.

	2. The learner understands that water is part of many different complex global interrelationships and systems. 3. The learner knows about the global unequal distribution of access to safe drinking water and sanitation facilities. 4. The learner understands the concept of "virtual water". 5. The learner understands the concept of Integrated Water Resources Management (IWRM) and other strategies for ensuring the availability and sustainable management of water and sanitation, including flood and drought risk management.
77	1. The learner knows about different energy resources – renewable and non-renewable – and their respective advantages and disadvantages including environmental impacts, health issues, usage, safety and energy security, and their share in the energy mix at the local, national and global level. 2. The learner knows what energy is primarily used for in different regions of the world. 3. The learner understands the concept of energy efficiency and sufficiency and knows socio-technical strategies and policies to achieve efficiency and sufficiency. 4. The learner understands how policies can influence the development of energy production, supply, demand and usage. 5. The learner knows about harmful impacts of unsustainable energy production, understands how renewable energy technologies can help to drive sustainable development and understands the need for new and innovative technologies and especially technology transfer in collaborations between countries.
88	1. The learner understands the concepts of sustained, inclusive and sustainable economic growth, full and productive employment, and decent work, including the advancement of gender parity and equality, and knows about alternative economic models and indicators. 2. The learner has knowledge about the distribution of formal employment rates per sector, informal employment, and unemployment in different world regions or nations, and which social groups are especially affected by unemployment. 3. The learner understands the relation between employment and economic growth and knows about other moderating factors like a growing labor force or new technologies that substitute jobs. 4. The learner understands how low and decreasing wages for the labor force and very high wages and profits of managers and owners or shareholders are leading to inequalities, poverty, civil unrest, etc. 5. The learner understands how innovation, entrepreneurship and new job creation can contribute to decent work and a sustainability-driven economy and to the decoupling of economic growth from the impacts of natural hazards and environmental degradation.
99	1. The learner understands the concepts of sustainable infrastructure and industrialization and society's needs for a systemic approach to their development. 2. The learner understands the local, national and global challenges and conflicts in achieving sustainability in infrastructure and industrialization. 3. The learner can define the term resilience in the context of infrastructure and spatial planning, understanding key concepts such as modularity and diversity, and apply it to their local community and nationwide. 4. The learner knows the pitfalls of unsustainable industrialization and in contrast knows examples of resilient, inclusive, sustainable industrial development and the need for contingency planning. 5. The learner is aware of new opportunities and markets for sustainability innovation, resilient infrastructure and industrial development.
110	1. The learner knows different dimensions of inequality, their interrelations and applicable statistics. 2. The learner knows indicators that measure and describe inequalities and understands their relevance for decision-making. 3. The learner understands that inequality is a major driver for societal problems and individual dissatisfaction.

	4. The learner understands local, national and global processes that both promote and hinder equality (fiscal, wage, and social protection policies, corporate activities, etc.). 5. The learner understands ethical principles concerning equality and is aware of psychological processes that foster discriminative behavior and decision making.
111	1. The learner understands basic physical, social and psychological human needs and is able to identify how these needs are currently addressed in their own physical urban, peri-urban and rural settlements. 2. The learner is able to evaluate and compare the sustainability of their and other settlements' systems in meeting their needs particularly in the areas of food, energy, transport, water, safety, waste treatment, inclusion and accessibility, education, integration of green spaces and disaster risk reduction. 3. The learner understands the historical reasons for settlement patterns and while respecting cultural heritage, understands the need to find compromises to develop improved sustainable systems. 4. The learner knows the basic principles of sustainable planning and building and can identify opportunities for making their own area more sustainable and inclusive. 5. The learner understands the role of local decision-makers and participatory governance and the importance of representing a sustainable voice in planning and policy for their area.
112	1. The learner understands how individual lifestyle choices influence social, economic and environmental development. 2. The learner understands production and consumption patterns and value chains and the interrelatedness of production and consumption (supply and demand, toxics, CO2 emissions, waste generation, health, working conditions, poverty, etc.). 3. The learner knows roles, rights and duties of different actors in production and consumption (media and advertising, enterprises, municipalities, legislation, consumers, etc.). 4. The learner knows about strategies and practices of sustainable production and consumption. 5. The learner understands dilemmas/trade-offs related to and system changes necessary for achieving sustainable consumption and production.
113	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 catalyzing, 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.
114	1. The learner understands basic marine ecology, ecosystems, predator-prey relationships, etc. 2. The learner understands the connection of many people to the sea and the life it holds, including the sea's role as a provider of food, jobs and exciting opportunities. 3. The learner knows the basic premise of climate change and the role of the oceans in moderating our climate. 4. The learner understands threats to ocean systems such as pollution and overfishing and recognizes and can explain the relative fragility of many ocean ecosystems including coral reefs and hypoxic dead zones. 5. The learner knows about opportunities for the sustainable use of living marine resources.
115	1. The learner understands basic ecology with reference to local and global ecosystems, identifying local species and understanding the measure of biodiversity.

	2. The learner understands the manifold threats posed to biodiversity, including habitat loss, deforestation, fragmentation, overexploitation and invasive species, and can relate these threats to their local biodiversity. 3. The learner is able to classify the ecosystem services of the local ecosystems including supporting, provisioning, regulating and cultural services and ecosystems services for disaster risk reduction. 4. The learner understands the slow regeneration of soil and the multiple threats that are destroying and removing it much faster than it can replenish itself, such as poor farming or forestry practice. 5. The learner understands that realistic conservation strategies work outside pure nature reserves to also improve legislation, restore degraded habitats and soils, connect wildlife corridors, sustainable agriculture and forestry, and redress humanity's relationship to wildlife.
116	1. The learner understands concepts of justice, inclusion and peace and their relationship to law. 2. The learner understands their local and national legislative and governance systems, how they represent them and that they can be abused through corruption. 3. The learner is able to compare their system of justice with those of other countries. 4. The learner understands the importance of individuals and groups in upholding justice, inclusion and peace and supporting strong institutions in their country and globally. 5. The learner understands the importance of the international human rights framework.
117	1. The learner understands global issues, including issues of financing for development, taxation, debt and trade policies, and the interconnectedness and interdependency of different countries and populations. 2. The learner understands the importance of global multi-stakeholder partnerships and the shared accountability for sustainable development and knows examples of networks, institutions, campaigns of global partnerships. 3. The learner knows the concepts of global governance and global citizenship. 4. The learner recognizes the importance of cooperation on and access to science, technology and innovation, and knowledge sharing. 5. The learner knows concepts for measuring progress on sustainable development.

Table 2: *Cognitive learning objectives of the 17 SDGs* (UNESCO, 2017, p. 12-44)

CURRICULAR GUIDELINES FOR PRIMARY EDUCATION IN CHILE

Chilean boys and girls receive an education in accordance with the provisions of the curricular bases for primary education (MINEDUC, 2018). These bases allow students of this stage to develop critical and creative thinking and communication and reflection skills, acquire the necessary autonomy to participate in society, and foster their ability to undertake projects. For this, these curricular bases not only establish the Plans and Study Programs organized around knowledge and skills to guarantee the learning required for all subjects, such as Language and Communication, Mathematics, Natural Sciences, History, Geography and Social Sciences, among others; but also uphold the transversal objectives included in the 2009 Curriculum Framework, which link up men, society and the education. In this sense, these objectives must be effectively implemented in the educational processes to strengthen the ethical formation of the students, guide the process of personal growth and self-affirmation, and give them orientation on how to relate to others in the world (MME, 2012). Likewise, they must organize LOs according to categories grouping them with greater precision within the dimensions indicated in the General Law of Education of Chile (Law No. 20710) and ensure the relevance of these objectives according to students' age. In this

way, these objectives, as shown in table 3, are framed in the students' personal development and moral and social behavior, and are applicable in the physical, affective, sociocultural, spiritual and cognitive dimensions.

Dimension	Transversal objectives
Physical	Encourage personal physical development and self-care in the context of valuing life and one's own body, through hygiene habits, risk prevention and healthy lifestyle habits. Practice physical activity appropriate to own interests and abilities.
Affective	Acquire a positive sense of life, a healthy self-esteem and self-confidence based on personal knowledge, both of its potentialities and its limitations. Understand and appreciate the importance of affective, spiritual, ethical and social dimensions for healthy sexual development. Appreciate the social, emotional and spiritual importance of the family for the integral development of its members and of the whole society.
Cognitive	Identify, process and synthesize information from various sources and organize relevant information about a topic or problem. Organize, classify, analyze, interpret and synthesize information and establish relationships among the different learning subjects. Present ideas, opinions, convictions, feelings and experiences in a coherent and well-founded way, making use of diverse and varied forms of expression. Solve problems in a reflective way in the school, family and social environment, both using models and routines and creatively applying concepts and criteria. Design, plan and carry out projects.
Sociocultural	Value life in society as an essential dimension of personal growth, and act in accordance with values and norms of civic, peaceful and democratic coexistence, knowing one's rights and responsibilities, and assuming commitments with oneself and with others. Value commitment in relationships between people and when agreeing contracts: in friendship, in love, in marriage, at work and when undertaking projects. Participate in solidarity and responsibly in the activities and projects of the family, the establishment and the community. Know and value the history and its actors, traditions, symbols, territorial and cultural heritage of the nation in the context of an increasingly globalized and interdependent world. Recognize and respect equal rights between men and women and appreciate the importance of developing relationships that enhance their equitable participation in family economic, social and cultural life. Protect the natural environment and its resources as a context for human development.
Moral	Responsibly exercise increasing degrees of freedom and personal autonomy in accordance with values such as justice, truth, solidarity and honesty, respect, the common good and generosity. Know, respect and defend the equality of essential rights of all people, without distinction of sex, age, physical condition, ethnicity, religion, economic situation, and act in accordance with the ethical principle that recognizes that all human beings are born free and equal in dignity and rights and endowed with reason and conscience, they must behave fraternally with one another.

	Value the unique character of each human being and, therefore, the diversity that is manifested among people, and develop the capacity for empathy with others. Recognize and respect cultural, religious and ethnic diversity and ideas and beliefs different from one's own in school, family and community spaces, recognizing dialogue as a source of growth, overcoming differences and approaching the truth.
Spiritual	Recognize human finitude. Recognize and reflect on the transcendent and / or religious dimension of human life.
Proactivity and work	Show interest in knowing reality and using knowledge. Practice personal initiative, creativity and an entrepreneurial spirit in the personal, school and community spheres. Work as a team in a responsible way, building relationships based on mutual trust. Understand and value perseverance, rigor and compliance, on one hand, demonstrate flexibility, originality, acceptance of advice and critics, on the other, take risks as fundamental aspects in the development and successful completion of tasks and jobs. Recognize the importance of work, both manual and intellectual, as a form of personal, family and social development and of contribution to the common good, valuing the essential dignity of all work and the eminent value of the person who performs it.
Information and communication technologies (ICTs)	Search, access and evaluate the quality and relevance of information from various virtual sources. Use ICTs that solve information needs, accomplishing communication, expression and creation within the immediate educational and social environment. Use applications to present, represent, analyze and model information and situations, communicate ideas and arguments, and understand and solve problems efficiently and effectively, taking advantage of multiple media (text, image, audio and video). Participate in virtual communication networks and citizen information networks with creative and relevant contributions. Make a conscious and responsible use of ICTs, applying criteria of self-care and care of others in virtual communication and respecting the right to privacy and intellectual property.

Table 3: Transversal objectives of the Curricular Bases by dimensions (MINEDUC, 2018, p.31)

On the other hand, the LOs by level and subject correspond to the expected terminal learning at a given level and subject. These LOs refer to skills, knowledge and attitudes. According to MINEDUC (2012):

> "Skills are abilities to perform tasks and to solve problems with precision and adaptability. The knowledge corresponds to concepts, concept networks and information about facts, processes, procedures and operations. Attitudes are dispositions learned to respond, in a favorable or unfavorable way, to objects, ideas or people; include affective, cognitive and evaluative components that incline people to certain types of actions" (MINEDUC, 2012, p. 22).

Due to the objective of this study and what was explained above, the LOs of the Data and Probabilities axis of Mathematics, Natural Sciences and Social Sciences are characterized

below. According to MINEDUC (2018), the LOs for the teaching of mathematics, in particular the axis of Data and Probabilities, for primary education students correspond to their first approach to the study of statistics and probability, where collecting data about situations about themselves and the environment is suggested. Therefore, it is essential that the content of this axis be worked from a real context and close to the students. In other words, these contexts could be a social, economic and environmental situation that is related to the LOs of the different curricular subjects, such as, for example, Natural Sciences and Social Sciences.

As for the Natural Sciences LOs, these are focused on the scientific literacy of students in order to promote the understanding of the great ideas of science, the management of the scientific method and the acquisition of scientific thinking skills and scientific attitudes such as: responsibility, teamwork, respect and permanent interest in the facts of the natural environment. The development of these LOs will help literate students scientifically, that is, to be able to apply the great ideas of science to everyday experiences, in addition to interpreting situations or phenomena based on data processed with the use of ICTs (Carrión-Martínez et al., 2020). In short, it is about providing them with opportunities to link their study to the use of ICTs, which will lead to the development of various projects and activities in all stages of scientific learning (Bascopé et al. 2019).

The LOs of the Social Sciences subject aim at helping students acquire a sense of identity and belonging to society, based on the recognition of their community and respect for others, themselves, and diversities, in a way that they can interact and consolidate ties with the society.

MATERIALS AND METHODS

The objective of this study is to identify links between stochastic education (particularly, the Data and Probabilities axis of the Mathematics subject) and the thematic contents of Natural Sciences and Social Sciences in the Chilean primary education curriculum. For this, it was necessary to carry out an approximation by means of an exploratory qualitative descriptive methodology and through the design of content analysis (Ynoub, 2016).

Sample and unit of analysis

The sample is intentional. The LOs of the study plans and programs of the eight levels of primary education (from the first to the eighth level) of Mathematics (axis of Data and Probabilities), Natural Sciences and Social Sciences published by the Ministry of Education of Chile (2012) were selected as the units of analysis, involving, in total, 24 plans and programs.

Analysis Category

Due to the above, the following categories of analysis were established:

1. Nexus among stochastic education, Natural Sciences and Social Sciences: This association is determined when a stochastic education LO at one level can be taught from a context identified in a Natural or Social Sciences LO at the same level.
2. Nexus between the cognitive descriptors of the 17 SDGs (table 2) and the LOs of Natural Sciences and Social Sciences.

Analysis procedure

To carry out this research, the units of analysis of each of the study plans and programs were first identified (Table 4). Subsequently, a content analysis was performed based on the categories described above, which were systematically and objectively identified (Vásquez, 2020; Vásquez & García-Alonso, 2020) by using Microsoft Excel spreadsheet. For this, first, the LOs of all Natural Sciences and Social Sciences plans and programs were examined, and all those that denoted a link with the LOs of Data and Probabilities were selected. Second, those selected Natural Sciences and Social Sciences LOs that provide a context to develop the cognitive concept of some SDGs (see Table 2) were identified.

Level	Selected pages of the mathematics study program (Data and Probabilities axis)	Selected pages of the Social Sciences study program	Selected pages of the Natural Sciences study program
1st	*42,105,119,129,136,138,182.*	*59,65,73,79,86,95,97,104,111,116, 123,135,141*	*56,58,69,79,85,91,120,121,125,12 8,129*
2nd	*116,125,136,137,142,143*	*59,67,70,78,84,85,87,92,95,96,97, 102,104,121,112,122,128,129,131, 136,139*	*59,66,84,86,94,89,85,91,96,104,1 8,136,130,131,141,145*
3rd	*117,130,118,137,133,132*	*80,97,110,104,138,147,153*	*42,105,119,125,134,135,139,137, 40*
4th	*129,136,140*	*62,72,91,103,108,115,124,128,137, 139*	*117,125,128,138,143,148*
5th	*142,148,150,143,152,144*	*84,94,98,101,61,69,71,77,113,122, 126,140,142,145,149,141,62,66,71 ,141,143*	*58,59,60,62,64,72,74,7783,89,10(107,111,113,117,118,126,135*
6th	*132,137,139,143,144*	*65,70,74,76,78,80,130,131,144,14 8,164,166,174,177*	*61,62,76,83,96,97,100,101,102,1(5,106,114,115,119,121,123,126,1 7,129*
7th	*164,165,166,169,172,175*	*47,68,84,86,137,225,255,256,304, 306,308,316,319,322,325,328,334,*	*30,31,33,66,68,82,83,84,101,123, 25,137,185,210,231,257,308*
8th	*58,169,170,176,180,184,186,188*	*30,200,203,208,276,363,364,367,3 77,423*	*81,83,111,114,122,135,151*

Table 4: Selected pages of Chilean study programs at each level and subject

From here on, an example of the data analysis process is shown:

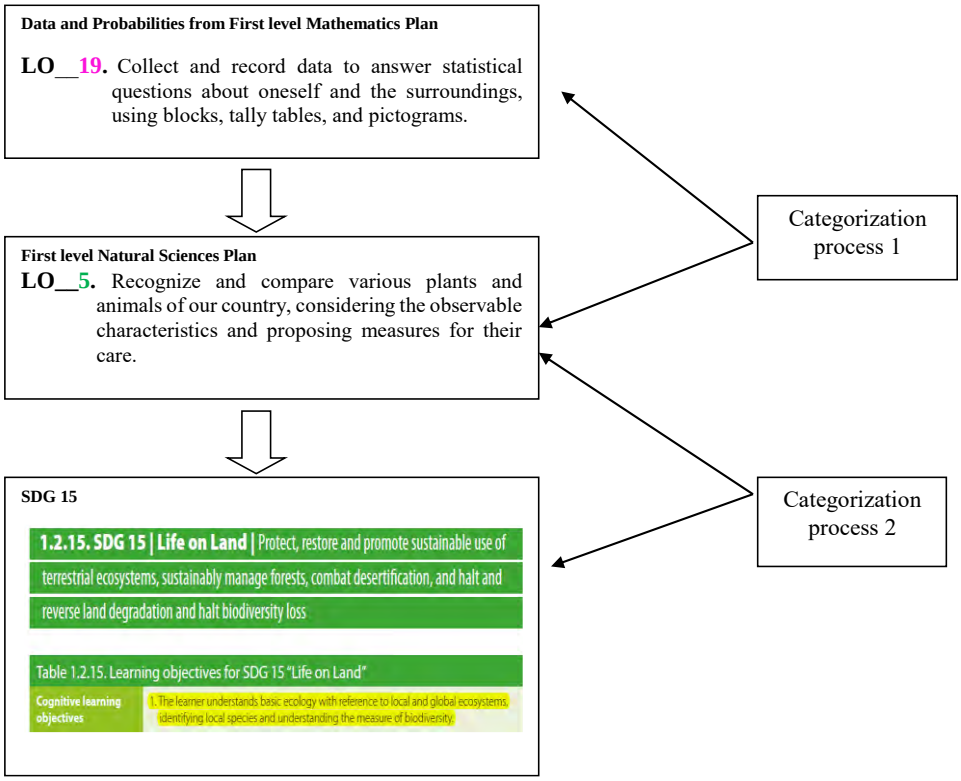

Figure 2: Nexus categorization process

The figure shows that LO 19 of the Data and Probabilities axis at the first level can be linked with LO 5 of the Natural Sciences plan and program at the same level. At the same time, LO 5 is also linked to the first cognitive descriptor of the ODS15. In other words, LO 19: "recognizing and comparing various plants and animals in our country, considering the observable characteristics and proposing measures for their care" has been one of the LOs identified in the first level Natural Sciences because it is linked to "identifying local species" (SDG 15 cognitive descriptors, Table 2).

RESULTS

The results are comprised of three parts. First, showing the results related to the first category, specifically the nexuses between stochastic education and Natural Sciences. Secondly, showing the results related to the first category, this time, the nexuses between stochastic education and Social Sciences. Subsequently, showing the results related to the second category, which means the nexuses between the results obtained in the first category and the SDGs.

Nexuses between stochastic education and Natural Sciences

The analysis of the data showed 66 nexuses between the LOs of stochastic education and the LOs of Natural Sciences. Likewise, it could be observed that most nexuses were found (20 nexuses) at the fifth level, while at the eighth level the least nexuses were found (4 nexuses).

Below, figures 3 and 4 show some examples of the identified nexuses.

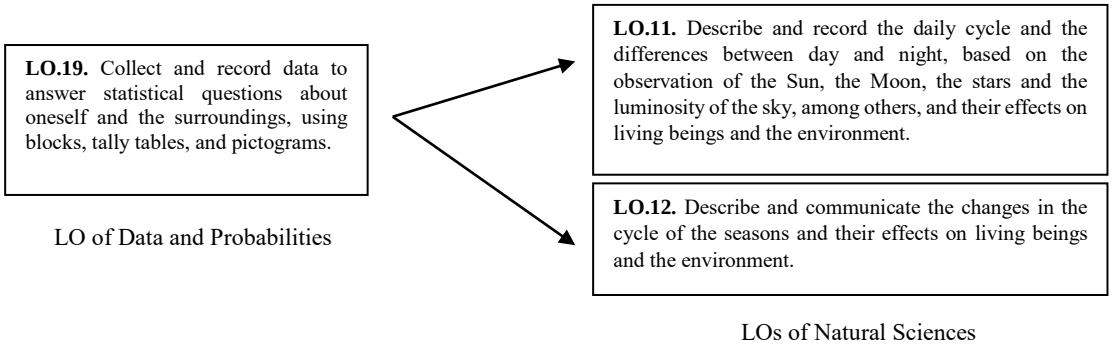

Figure 3: Data and Probabilities LO that links with Natural Sciences LOs at the first level

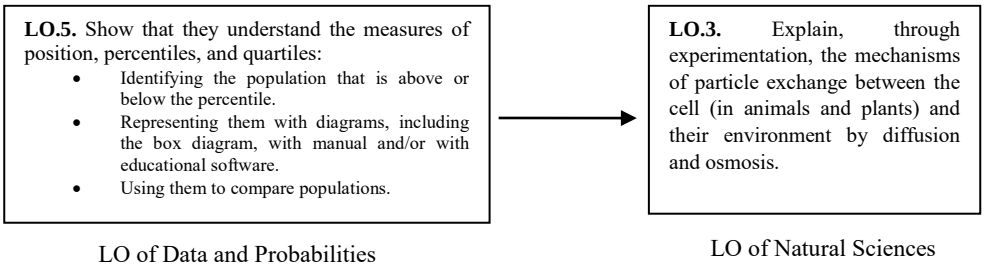

Figure 4: Data and Probabilities LO that links with Natural Sciences LO at the eighth level

Nexuses between stochastic education and Social Sciences

The analysis of the data showed the existence of 65 nexuses between the LOs of stochastic education and the LOs of Social Sciences. Likewise, it could be observed that the most nexuses were found (17 links) at the fifth level, while at the eighth level there were the least nexuses (2 links). Figures 5 and 6 blow show some examples of the identified nexuses.

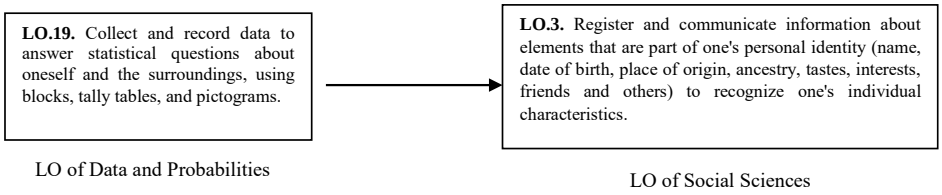

Figure 5: Data and Probabilities LO that links with Social Sciences LO at the first level

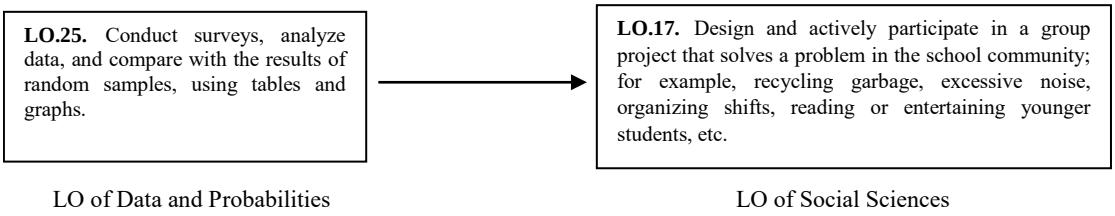

Figure 6: Data and Probabilities LO that links with Social Sciences LO at the fourth level

Nexuses between the results obtained in the first category and the SDGs

Once the previous nexuses had been identified, the next step is to identify those LOs of Natural Sciences and Social Sciences that, at the same time, had nexuses with the SDGs. (Figures 7 and 8).

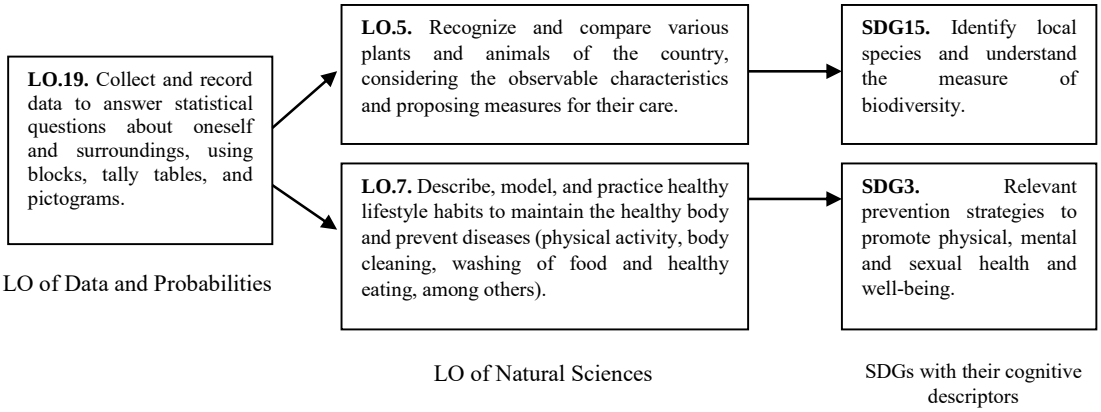

Figure7: Data and Probabilities LO that links with Natural Sciences LOs at the first level, and with SDGs

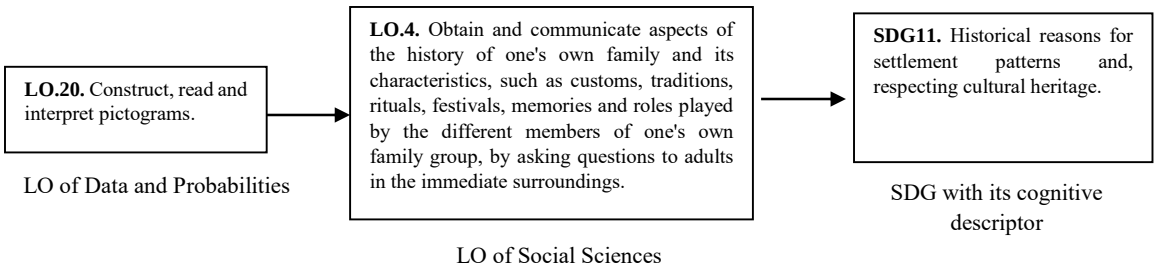

Figure 8: Data and Probabilities LO that links with Social Sciences LO at the first level, and with SDGs

Thus, Table 5 shows the results obtained based on the second category of analysis, that is, the nexuses between the LOs of Natural Sciences and the SDGs.

SDGs	Level									
	1st	2nd	3rd	4th	5th	6th	7th	8th	Total	%
SDG1									*0*	0
SDG2			*3*		*4*				*7*	6,0%
SDG3	*2*		*8*	*1*	*11*	*6*	*2*		*30*	25,6%
SDG4									*0*	0,0%
SDG5						*2*			*2*	1,7%
SDG6		*3*	*2*	*1*	*2*				*8*	6,8%
SDG7	*2*		*2*		*3*	*3*			*10*	8,5%
SDG8									*0*	0,0%
SDG9					*3*	*1*	*1*		*5*	4,3%
SDG10									*0*	0,0%
SDG11				*2*	*5*	*2*			*9*	7,7%
SDG12			*2*	*1*	*7*	*4*			*14*	12,0%
SDG13		*3*		*1*	*3*				*7*	6,0%
SDG14		*5*		*1*	*6*				*12*	10,3%
SDG15	*2*	*5*		*3*	*3*				*13*	11,1%
SDG16									*0*	0,0%
SDG17									*0*	0,0%
Total	6	16	17	10	47	18	3	0	117	100,0%
%	5,1%	13,7%	14,5%	8,5%	40,2%	15,4%	2,6%	0,0%	100,0%	100,0%

Table 5: SDGs linked to the LOs of Natural Sciences and the LOs of Data and Probabilities from the first to the eighth level mathematics plans.

Table 5 shows 117 nexuses among the SDGs and the selected LOs of the Natural Sciences curriculum. In this line, as shown in figure 9, SDG 1, 4, 8, 10, 16, 17 do not show any nexuses, while SDG 3 shows nexus with the 1st, 3rd, 4th, 5th, 6th, and 7th levels.

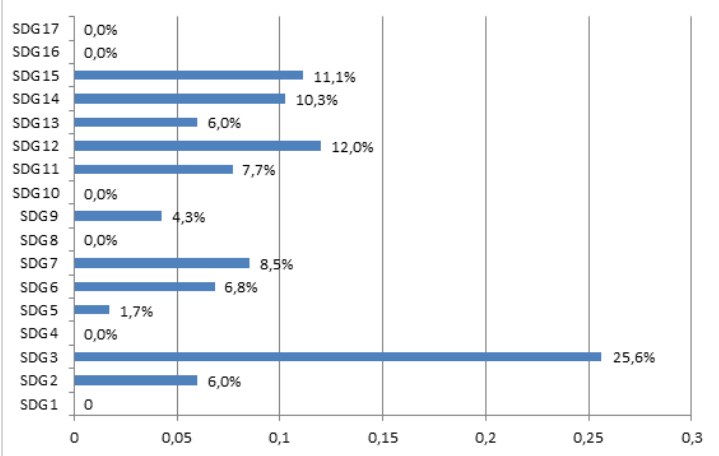

Figure 9: Percentage of SDGs identified in the Natural Sciences curriculum

In figure 10, it is evident that the eighth level is the one that does not link with any SDG. On the other hand, the fifth level is the one with the most LOs linked to SDGs (42%); at the same time, it has the highest number of linked SDGs (10 out of 17 SDGs, except for SDGs 1, 4, 5, 8.10, 16, 17).

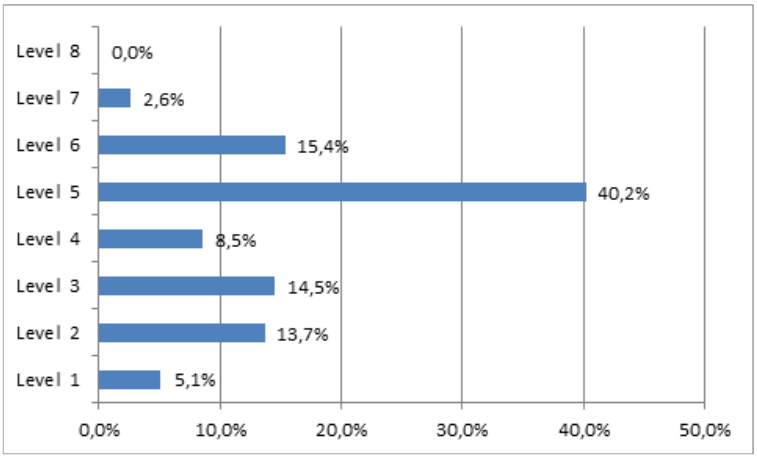

Figure 10: Percentage of the identified SDGs in terms of the LOs of the Natural Sciences at different levels

Likewise, table 6 shows the nexuses between the LOs of Social Sciences and the SDGs, there are 40 nexuses between the different SDGs and the LOs selected from the Social Sciences curriculum.

SDGs	Level									
	1st	2nd	3rd	4th	5th	6th	7th	8th	Total	%
SDG1									*0*	0
SDG2									*0*	0
SDG3		*1*							*1*	2,5%
SDG4					*2*		*1*		*3*	7,5%
SDG5		*1*					*1*	*1*	*3*	7,5%
SDG6									*0*	0,0%
SDG7							*2*		*2*	5,0%
SDG8					*3*		*1*		*4*	10,0%
SDG9									*0*	0,0%
SDG10					*3*			*1*	*4*	10,0%
SDG11	*4*	*2*		*2*	*1*		*1*		*10*	25,0%
SDG12	*3*								*3*	7,5%
SDG13							*2*		*2*	5,0%
SDG14						*1*			*1*	2,5%
SDG15			*1*						*1*	2,5%
SDG16	*1*		*5*						*6*	15,0%
SDG17									*0*	0,0%
Total	8	4	6	2	9	1	8	2	40	100,0%
%	20,0%	10,0%	15,0%	5,0%	22,5%	2,5%	20,0%	5,0%	100,0%	100,0%

Table 6: SDGs linked to the LOs of Social Science and the LOs of Data and Probabilities from the first to the eighth level mathematics plans

The results show that not all the SDGs are approachable with the Data and Probability LOs in the context of the Social Sciences subject. As shown in figure 11, in case of SDG 1, 2, 5, 6, 9, and 17, there are no any nexuses. On the other hand, SDG 11 shows a greater number of nexuses with the LOs of 1st, 2nd, 4th, 5th, 7th levels. Likewise, it is also the one with the highest frequency of nexuses (25%) with the Social Sciences LOs.

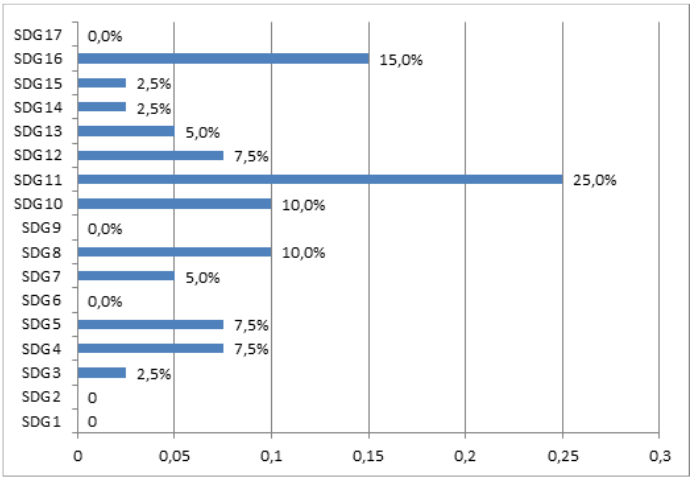

Figure11: Percentage of the SDGs identified in the Social Sciences curriculum

As shown in figure 12, all of the levels have nexus with the SDGs. Moreover, the fifth level is the one with the highest frequency of nexuses with the different SDGs (22.5%).

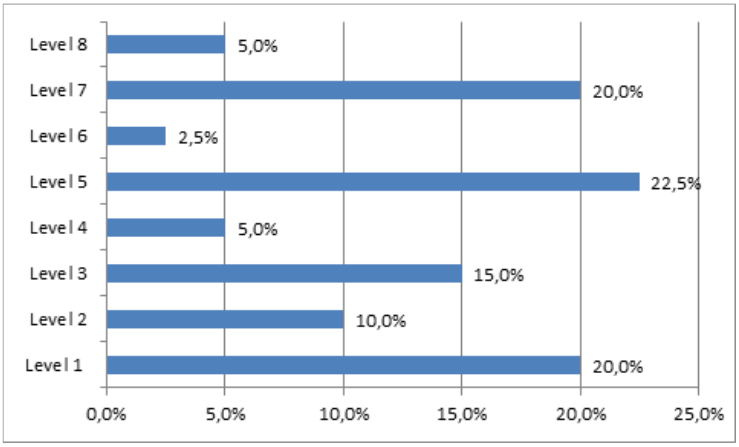

Figure 12: Percentage of the SDGs identified in terms of the LOs of the Social Sciences levels

From table 5 and 6, it is evident that the Social and Natural Sciences curricula provide favorable contexts for students to address stochastic issues related to the SDGs from the first to the eighth level of primary education. However, it should be noted that not all LOs manage to link to the SDGs. In light of the results, the difficulty of linking some LOs from the stochastic education field is highlighted, given their specificity, which limits their nexus with the context of the Natural Sciences and/or Social Sciences that are addressed at different school levels. Table 4 shows the LOs that represent the aforementioned difficulty.

Level	Los
2nd	20. Collect and register data to answer statistical questions about dice and coin games, using blocks and tally tables and pictograms.
	21. Register, in charts and simple bar graphs, the results of random games with dice and coins.
3rd	24. Register and order data obtained from random games with dice and coins, finding the smallest, the largest and estimating the midpoint between them.

Table 7: Data and Probability LOs that are not linked to Natural and Social Sciences LOs at the same level

Given that second and third level LOs are situated in a specific context of random play with dice or coins, it is difficult to make an explicit link with context in the field of Natural and/or Social Sciences.

CONCLUSIONS

The present study set out to establish links among the learning objectives of stochastic education, Natural Sciences and Social Sciences of the Chilean curriculum and, based on this, to establish links with ESD of Chilean primary education at the levels.

Upon the results, it is observed that the LOs of the stochastic topics of the mathematics curriculum are linked to the Natural Sciences and Social Sciences curricula, allowing ESD to be developed in an interdisciplinary way (with these two subjects and stochastic topics). Specifically, the first to the eighth level of primary education offer context to address SDG 3 and SDG9 in their Natural Sciences LOs; and SDG4, SDG5, SDG8 and SDG10 in Social Sciences LOs.

Considering the particularities of the LOs of these subjects and the cognitive dimension transversal objective that intends to "organize, classify, analyze, interpret and synthesize the information and establish relationships among the different learning subjects" (MINEDUC, 2018, p.29), we highlight the opportunity offered by the curricular bases for primary education in Chile, and the interest of this study in establishing more clearly the nexuses that the Data and Probabilities axis may have with another area of study. Specifically, recognizing how the Social and Natural Sciences can provide an interesting context to address Data and Probabilities from an educational point of view for sustainable development, in addition, it has been confirmed that the Social and Natural Sciences curricula promote contexts so that students can link ESD with stochastic education, (Alsina & Mulá 2019; Vásquez, 2020). There is an example:

To address LO19 of the data and probability axis (collect and record data to answer statistical questions about oneself and the environment, using blocks, tally charts, and pictograms) in class, the teacher can present a contextualized problem regarding Chilean children obesity.

Since this allows interdisciplinary work in the context of LO7 of the Natural Sciences curriculum and formulates preventive strategies to address SDG3 from the cognitive dimension. First, the teacher can tell the students what obesity is, its cause, and its consequence. The next step is to ask the children to measure their classmates' weight and height, help them key in the data in a spreadsheet with incorporated BMI (body mass index) formula to obtain each one's nutritional status, such as [severe malnutrition], [potential malnutrition], [weight within normal range] among others. And finally, make an anonymous chart to illustrate the number of underweight, average weight, overweight, obese or severely obese and discuss how to face obesity and have a healthy life. With this in-class activity, the children can acquire stochastic abilities and become aware of their health conditions.

In this sense, teachers have to appreciate this interdisciplinary link between ESD and stochastic education to help students acquire knowledge and transversal competences to promote the sustainable development.

Consequently, it is observable that the development of ESD from the cognitive domain, contextualization and the integration of these subjects and stochastic education allow statistical and probabilistic literacy, as well as the formation of sustainability competencies (Alsina & Mulá, 2019; Vásquez & García-Alonso, 2020; Vásquez, 2020).

In subsequent studies, it will be necessary to address more precisely the characteristics that primary education teachers initial and continuing training programs should have in order to move towards Education for Sustainable Development in the school classroom, as well as to analyze more precisely the necessary aspects for teachers to acquire specialized knowledge that contributes to promoting sustainability competencies. The above makes even more sense, if we consider that primary education teachers do not have the necessary tools to incorporate ESD through general mathematics education and, in particular, through stochastic education (Vásquez, Seckel & Alsina, 2020; Vásquez & García-Alonso, 2020).

SPECIAL THANKS

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