Integrating Interculturality in Education for Sustainable Development

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Integration of Interculturality in Education for Sustainable Development

In response to global environmental challenges, there has been a growing demand over the last century to develop the field of Education for Sustainable Development (ESD). While most research in the ESD field recognizes the importance of the cultural dimension, very few studies focus on interculturality. Despite its importance in promoting international cooperation and consensus, the development of intercultural competencies has not been consistently studied. This article examines the relationship between ESD and intercultural education by analyzing two pedagogical experiments with school groups in Guadeloupe and Quebec who worked synchronously and collaboratively on sustainable development themes. Our analysis shows that many competencies acquired during the experiments are characteristic of ESD, such as behavioral and emotional skills, including communication and empathy. This supports the idea that culture and interculturality can serve as a catalyst for ESD. Designing pedagogy based on interculturality can enhance the understanding of sustainable development issues and foster the development of crucial SD competencies.

Keywords: collaboration, competencies, interculturality, sustainable development, educational technology, DBR methodology.

Introduction

The organization of information about what constitutes sustainable development (SD) is relatively complex, as this is a concept that may seem abstract. It falls under several disciplinary fields and their interactions, has temporal and spatial dimensions, and is associated with different scales (an individual and human scale, a regional or country-wide scale, and also a planetary scale). Furthermore, it requires a global consortium bringing together the greatest possible number of actors for the development of a new societal model.

In defining SD, the Brundtland Report states that “humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). According to this report, we need to contemplate growth that is economically, socially and

environmentally sustainable and viable. This involves a process of long-term thinking, which is critical for the survival of the human species. The definition of SD stemming from the Brundtland Report was widely accepted and is now used in government documents, as well as by organizations that manage the global SD policy, such as the United Nations (UN) and one of its agencies in particular: the United Nations Educational, Scientific and Cultural Organization (UNESCO). However, this description has often been challenged, as the term "development" refers to growth and economic objectives, whereas the initial motivation should be the environment (Kopnina, 2020). Certain authors concur that the word "transformation" may be more appropriate, as it would allow for the inclusion of economic decline or degrowth, and thus placing the environment at the center of the goals (Barthes & Alpe, 2014; Clément & Caravita, 2011). We are aware that there is also a debate between the use of the terms "education for sustainable development" and "environmental education." We consider that ESD focuses on many other aspects of society, including politics and the economy, that are not necessarily addressed in environmental education, and we will continue to use this term.

SD has been described historically using indicators, dimensions, problems or even themes, and was finally defined as a project, to be carried out based on 17 goals (Sustainable Development Goals or SDGs) to be achieved in 2030 (UNESCO, 2017). More than a notion or a concept, the term "sustainable development" can also be used as an analytical frame of reference or as a normative frame of reference (Rousseau & Zuindeau, 2007), thus making it possible to analyze data or create projects according to a particular framework.

In this article, we will see how a context effect-based pedagogical experiment and the intercultural and contextual dimensions associated with it can constitute a framework for sustainable development education (ESD) and how it can help to develop sustainable development competencies.

With regard to these competencies, few descriptions can be found in ESD literature pertaining to culture, interculturality and intercultural education, which we are analyzing in order to identify their essential nature. Finally, the contribution of ESD competencies and that of interculturality are evaluated in order to show how they complement each other.

Education as the foundation of sustainable development

Education is an important factor in SD in several respects. Beyond being a part of the SDGs (the 4th one: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."), it is a central factor in SD, as it is a driver of societal transformation (Lange, 2014). It could be considered as the common foundation of the three pillars (economic, social and environmental pillars) of SD in the sense that we need education to accomplish the SDGs. Educating future generations about the issues of SD is no doubt the best way to significantly raise awareness and equip students with knowledge and competencies to support SD.

However, transforming education, on the theoretical, practical and structural levels, according to the SD framework, is a difficult task owing to its international, intercultural and intercontextual nature. Nevertheless, a global education agenda for SD was gradually put in place through some countries' national programs. Such an agenda is sometimes controversial because it may be perceived as being domineering, or because it is characterized by political ambition (Berryman & Sauvé, 2016; Kopnina, 2020; Sauvé, 2006). As underscored by Freire (1971), education is never neutral and all educational practices are political, as they always have embedded values, plans and utopias that replicate, legitimize, challenge or transform the relationships of power that prevail in society. But the global and consensual nature of SD requires education on this subject to be established in the same way, that is, internationally consistent.

Competencies and ESD

The term “competency” has several definitions that can be debated according to the discipline. For example, in the fields of education psychology and sociology, and in the professional domain, the term does not refer to the same notions. Nevertheless, among these definitions, a certain linearity remains. In this paper, we consider the competency in the educational field as “a complex know-how based on the mobilization and combination of a variety of internal and external resources within a family of situations” (Tardif, 2006). The choice of the competency definition is generally made according to the discipline in which the research is carried out (Clément & Caravita, 2011; OCDE, 2005), the learners’ level, the sector or the learning objectives. Furthermore, the term is often used to cover a broad range of meanings (Gilbert & Parlier, 1992). The multidisciplinary nature of ESD, at all levels of society and throughout the lifespan of this field, make the choice of a framework to describe the competencies a delicate task. Our in-depth literature review on the competencies and pedagogical models of ESD has allowed us to note their diversity. The objective of ESD is to develop individuals’ competencies that enable them to reflect on their actions by considering their current and future impact with respect to social, cultural, economic and environmental dimensions, both from local and global perspectives (Cebrián et al., 2020). It aims to enable students to have a systemic, forward-looking and collective vision of the world of tomorrow, by integrating responsibility and ethics, and by allowing for the changes needed for humankind to live together in the future (Mulnet et al., 2016).

While some authors define SD competencies, other authors structure ESD competencies according to what could be considered as broad dimensions: cognitive (knowledge), practical or behavioural, and emotional (including values) (Ardoin et al., 2018; Clément & Caravita, 2011; UNECE, 2012; UNESCO, 2017). In these structures, the social aspect (also occasionally called the interpersonal aspect) is sometimes related to the emotional

dimension (UNESCO, 2017) and sometimes, to the practical one (KVP model in Clément et Carvita, 2020, Cebrian, 2020). Other authors provide lists of more specific competencies that are easily cross-referenced: problem solving, collaboration, communication, empathy, responsibility and systemic, strategic and anticipatory thinking for example (Leicht et al., 2018; Lozano et al., 2019; Wiek et al., 2015; Wiek et al., 2011). Other authors include more unusual competences such as computer skills (Ardoin et al., 2018), creativity, or motivation (Cebrián et al., 2020).

Our literature review on ESD competencies highlights the complexity and the difficulty of deciding which competencies are appropriate. Indeed, there is no firmly established definition of ESD, and its framework for education can be perceived as unstable or flexible (Jorgenson et al., 2019). This precariousness of ESD make it a challenge for education.

Nevertheless, instead of taking position on a specific theoretical framework ESD competencies, we have decided to adhere to general principles: ESD can be defined by using multidisciplinary, transdisciplinary and holistic approaches to develop systemic, critical and anticipatory thinking. It has to encourage values such as solidarity, equity, respect for people and nature, and social, individual and ecological responsibility. Finally, it has to help the development of social behaviors to enable communication and collaboration, and provide learners with the ability to change their perspective, and transform their habits. Our literature review also leads us to consider competencies in other disciplines that may be inherent to ESD, such as intercultural, psychosocial and digital competencies. These are explained in the next section.

Cultures, interculturality and intercultural education

The definition of culture has evolved over time. In the field of anthropology, one of the first definitions of the concept of culture is associated with the term “civilization” and views

culture as a complex whole that encompasses knowledge, beliefs, art, morals, law, customs, and the other abilities or habits acquired by human beings as members of society (Edward Tylor in Cuche, 2004).

According to the Mexico City Declaration on Cultural Policies, made at the World Conference on Cultural Policies (UNESCO, 1982), culture is "the whole complex of distinctive spiritual, material, intellectual and emotional features that characterize a society or social group, not limited to the arts and letters, and including modes of life, the fundamental rights of the human being, value systems, traditions and beliefs." This is also what defines the relationships that individuals have between and with one another, with their physical environment, the Earth, the cosmos, life and death.

According to Lévi-Strauss (1952) cited in Akkari (2009), the diversity of cultures does not stem from how remote they are, but from the relationships that they have. Through understanding cultures, it is possible to observe their hybrid nature. Culture is always derived from multiple origins, which does not prevent them from being distinct and unique (Akkari, 2009; Porcher, 1994). Thus, it seems meaningless to speak about cultures without speaking about their plurality and the interactions that they have.

The distinction between "pluriculturalism" and "multiculturalism" has already been documented and is not the point of this paper (Pantoja, 1975; Toll, 1997). Still, we submit that the difference between these two concepts stems from the nature of the interactions between groups that have distinct cultures. In multiculturalism, there is no dominant culture—each culture is isolated from the others and functions separately—, whereas in pluriculturalim, the various cultures evolve together and there is a notion of coexistence and integration (Pantoja et al., 1976).

Interculturality can be defined as all of the relationships and interactions between different cultures, generated when they meet and collide. In the words of Dumont (2008) in

Blanchet and Coste (2010), “To engage interculturally is to face the other, not to confront him/her, but to complement him/her, listen to him/her, open up to him/her, engage in dialogue with him/her.” In cultural education, it is essential to also address the interactive and diverse dimension of culture. Intercultural education must therefore consider multiple cultures and their interactions. Based on these definitions, we prefer to speak of pluriculturality and interculturality because we believe that these words are more relevant to an educational approach.

As stated by Akkari (2009), intercultural approaches in education aim to counteract the tendency of school actors to produce ethnocentric behaviours, which involve considering one’s culture as superior and using it as a model for humanity. This may involve value judgments about other people whose practices are incomprehensible to others because they are unknown and misunderstood. To implement intercultural approaches in education, cultural relativism is necessary. It involves evaluating the behaviours of individuals from different cultures in relation to their own cultural reference points. This requires knowledge of other cultures that can be achieved through pluricultural and intercultural projects.

Pluricultural competence includes the knowledge and experience of various languages and cultures as well as the ability to manage interaction, variation and subtleties with other cultures. It is a complex and heterogeneous competency that includes both unique and partial competencies, and forms a single overall repertoire that is available to the social actor concerned (Coste et al., 1997).

Stier (2009) considers intercultural competencies in the context of the internationalization of secondary education. The author’s description of these competencies is organized by content competencies, which can be associated with the field of knowledge, and by process competencies, which refer to the dynamic nature of intercultural competency and to its context of interaction (specific cultural features, situational conditions, and the actors

involved). Process competencies are also divided into intrapersonal and interpersonal competencies. Intrapersonal competencies are described as cognitive and emotional competencies (such as those dealing with and understanding a variety of feelings, preventing them from automatically determining one's actions or one's interpretations of behaviours or events). Interpersonal competencies refer to social or interactional competencies (the ability to understand verbal language and non-verbal variations).

Intercultural competencies are described by Dirks in the context of the expansion of a multinational corporation (Dirks, 1995) as follows: the importance ascribed to cultural, multicultural and intercultural knowledge at the end of the last century is due to globalization and the growth of the movements of intensification and geographical expansion of the trade of goods and capital. One of the goals of SD is to respond to the adverse consequences of this phenomenon of globalization (depletion of the planet's resources and loss of cultural identity, to name a few). Sustainability must be considered and put in place globally, but the major difficulty is learning from and with each other to improve acceptance and solidarity, which requires considering specific traits that are cultural and contextual. The actors of SD must then develop intercultural competencies in order to meet the goals of sustainability. The intercultural competency model, created for the global expansion of companies, can be a useful tool for managing SD competencies. These competencies are organized according to three components: (1) cognitive (recognizing local norms, customs and values; understanding local societal relationships; understanding verbal and non-verbal nuances); (2) emotional (demonstrating empathy and curiosity; accepting risks and having self-awareness); (3) social (listening and behavioural abilities, and collaboration).

This intercultural competency model can also easily be compared to the life skills found in the psychosocial competence model introduced by the World Health Organization (WHO) in 1993 (Birrell Weisen et al., 1996), which aims to organize the competencies to be

developed during a person's education and throughout life, in order to adopt behaviours that foster health and well-being. These competencies are described as the ability of a person to respond effectively to the requirements and challenges of daily life. They are organized according to three categories: social competencies (communication, empathy, negotiation, collaboration and arguing), cognitive competencies (critical thinking and self-assessment, problem solving and decision making), emotional competencies (managing emotions, positive thinking, self-confidence) (Mangrulkar et al., 2001). This model is structured in the same way as the intercultural competency model (Dirks, 1995).

Table 1 shows the similarities between the definitions of the intercultural competency according to Stier and Dirks and the definition of the psychosocial competency described in the previous paragraph.

Table 1: Intercultural and psychosocial competencies according to three dimensions

	Cognitive dimension	Emotional dimension	Social dimension
Intercultural competencies (Stier 2009)	Content competencies: Knowledge of both the *home* and of the *other* culture (history, customs, values, norms…)	Intrapersonal competencies: emotional competencies (dealing with and understanding a variety of feelings).	Interpersonal competencies: social or interactional competencies (ability to understand verbal language and non-verbal variations, communication).
Intercultural competencies (Dirks, 1995)	Cognitive (recognizing local norms, customs and values; understanding local societal relationships; understanding verbal and non-verbal nuances);	Emotional (demonstrating empathy and curiosity; accepting risks and having self-awareness)	Social competencies (listening and behavioural abilities, collaboration)
Life skills for psychosocial competence (Mangrulkar et al., 2001)	Cognitive competencies (critical thinking and self-assessment, problem solving and decision making)	Emotional competencies (managing emotions, positive thinking, self-confidence)	Social competencies (communication, empathy, negotiation, collaboration and arguing)

In Table 1, the competencies are organized according to the combination of identical dimensions: cognitive, emotional and social. Also, Table 1 shows that psychosocial and intercultural competencies both require robust emotional intelligence. Indeed, individuals need to be able to understand and manage their own emotions and those of others. They both require strong interpersonal skills, such as effective communication, empathy, and active listening, as individuals need to be able to connect and engage with people from different backgrounds. The similarities between intercultural and psychosocial competencies show the relevance of considering established and existing competency models when studying SD competencies.

Finally, in the current context of globalization, digital education for the young generation is also of key importance (Romero, 2017). Beyond the need to develop critical thinking and judgment pertaining to digital resources (Ministère de l'Éducation et de l'Enseignement supérieur, 2019a) [Quebec Ministry of Education and Advanced Education], it is essential to develop digital competencies for interactions and collaborations, in an intercultural context in order to meet the need for SD.

Rationale for including intercultural competencies in ESD

Based on the preceding analysis, it can be argued that the primary aim of SD is to regulate globalization by limiting the growth and exploitation of the planet's resources, to protect the future of humanity on Earth. But the Earth cannot be protected solely by establishing fair and equitable rules applicable to all societies and all sectors. It requires considering multiple cultures, environments, and contexts. As pointed out by Stier (2009), "global conditions are local concerns and local actions have global repercussions." Furthermore, culture is a vector of social cohesion and diversity, and is a source of sustainable means of subsistence and economic growth. In fact, if culture is valued and shared, it can foster dialogue and mutual understanding between people, and allow for new citizenship models to be developed, by

providing access to useful knowledge. (UNESCO, 2021).

It can be inferred from the global nature of SD that its education should also be global. Development cannot be sustainable and viable if there is no consensus in this regard. SD needs to take into consideration each country's problems and resources, as well as its needs. It is not necessarily the case that countries should be approached in an egalitarian manner, but they must be given equitable and consistent consideration. This also involves understanding the culture of these countries and taking it into account. In order for such a development ideology to be lasting, it must be transmitted through education and therefore through ESD. Thus, it becomes necessary for ESD to be able to consider the plurality and diversity of cultures, and their relationships and interactions. ESD must therefore aid understanding of interculturality and the tools of intercultural communication. It is crucial for the understanding of our living world and for the building of a global consortium with the aim of achieving SD. Yet, culture is not commonly accepted as a pillar of sustainability (WCED, 1987). This gap has already been pointed out by some authors (Tilbury & Mulà, 2009; Watene & Yap, 2015), who advocate for the integration of the cultural dimension into the social pillar. We believe that this integration should involve the understanding of cultural diversity and interculturality as one step towards tolerance, respect and peace (Kadigiannopoulos, 2020; UNESCO, 2006). Thus, interculturality and intercultural responsibility should be added to the goals that comprise SD. This is similar to integrating cultural diversity in our societies as part of the SD strategy. While a number of research studies pertaining to competencies in education for SD list competencies that are already well established in the sphere of intercultural competencies, the connection between the two competency areas (intercultural competencies and SD competencies) is not explicitly stated. For example, a critical vision, empathy, respect, self-awareness, interactional and behavioural competencies, and communication or interaction abilities are often cited as SD competencies (Cebrián et al., 2020; OCDE, 2005; UNESCO,

2017). The intercultural dimension is not always mentioned when ESD is discussed, and does not seem to be recognized as an ESD competency in the literature. However, intercultural competencies constitute an area of competencies that has already been thoroughly examined by the other communities of education researchers, and would benefit from being integrated as such in the research on ESD competencies.

Integrating ESD into the educational curriculum is complex, and many teachers lack familiarity with this field (Kerr, 2020). Over the last decade, numerous initiatives have been carried out to connect ESD goals with the application of ESD and with its viability for the development of school programs, conceptual models and instructional approaches. These initiatives also aimed to define ESD competencies. However, very few of them are based on experiments that included interactions and collaborations between people from different cultures. For example, the study by Clément, conducted in 2011 for UNESCO, presents 18 instructional practices pertaining to SD. Of these, only one practice addresses interculturality and cultural diversity. UNESCO also published a report, written by D. Tilbury and I. Mulà in 2009, which emphasises the lack of a cultural and an intercultural dimension in international policies and practices. Among other findings, the report shows that the integration of culture and interculturality is generally viewed as a challenge, rather than as an opportunity to come closer to achieving sustainability (Tilbury & Mulà, 2009).

Research Aim

As we have seen in our literature review, integrating interculturality into ESD practices still remains difficult. For this reason, in this project, we would like to test how interculturality can actually contribute to the development of ESD competencies through teaching based on the context as an entry point.

In order to carry out this test, we are relying on two pedagogical experiments that we conducted on the theme of SD. These experiments are based on an original pedagogical

approach: the context effect-based teaching and learning model. The basis of this approach is the participation of learners and teachers living in distinct geographical areas, teaching and learning collaboratively about common subjects that have local and cultural specificities. This approach includes synchronous and asynchronous exchanges between students and teachers from both contexts and the use of diverse digital and technologic tools. The two experiments described in this paper were put in place between two school groups, one in Guadeloupe and the other in Quebec. Guadeloupe and Quebec are two geographical areas contrasted by their climate, their environment, their culture, or their political, economic, legal or educational system, but whose commonalities such as the time zone and language (in spite of their variations of influences and accents) may allow for a fruitful collaboration.

The use of a context effect-based pedagogical model has already been trialled on a number of times and has undergone multiple analyses in different fields (Chartofylaka et al., 2018; Chartofylaka et al., 2021; Forissier, 2019). However, these analyses have always used the context as the central element and as a frame of reference. Here, we are attempting a different analysis, following an approach that focuses on intercultural aspects and SD, and on the underlying learning and teaching competencies. Our analysis can thus be qualified as an authentic analysis, compared to what has already be done in the field of context-effect research.

A sufficiently large number of intersections exist between the concepts of culture and context to support addressing culture through the prism of context. Our intention with this article is not to establish distinctions between these two concepts, as this would require an in-depth ontological analysis, which presents major challenges for specialists. In fact, the concept of culture is derived from the humanities and social sciences, whereas the concept of context also originates from the humanities and social sciences, but from the natural sciences as well. For the purposes of this article, our vision is therefore to take the intersection between

the concepts as a starting point to focus on the intercultural dimension. In particular, culture included the system of values and social consensus, whereas the context included such things as the geographical and geological situation. The intersection between the two concepts included language, history, economic and political systems.

As our framework targets the development of the ESD competencies, we are putting forward the hypothesis that an intercontextual pedagogical scenario may potentially stimulate the development of these competencies, including its intercultural dimension. The two fields (intercultural education and education for sustainable development) will be connected by characterizing the competencies that are sought and investigated during the instructional projects.

Instructional Methodology

Context Effect-Based Learning

Research in Education Sciences has shown the importance of context in the learning and teaching process, and has also made it possible to develop an original branch focusing specifically on context effect-based education (referred to later in the text by its French acronym of EBEC). This field of research is built on the fundamental idea that, during a learning activity, learners already have conceptions and knowledge (Giordan & de Vecchi, 1987), and that these prior conceptions are connected to their local context (Anjou, 2018).

In the field of context effect-based teaching and learning, learning could be associated with Bachelardian theories of epistemological obstacles (Bachelard, 1938). An epistemological obstacle is created when, in their mind, learners take the easy approach and use a "*ready-made*" explanation, whereas true learning occurs through a reconstruction or an organized rearrangement of these conceptions. When the learner becomes aware of this obstacle phenomenon, it generally induces some king of shock, called a cognitive conflict or a

socio-cognitive conflict if it is triggered by a social interaction. These phenomena are drivers for anchoring learning over the long term (Giordan & de Vecchi, 1987). Thus, the notion of "teaching and learning by *"obstacle-objective"*, introduced by Martinand (1986), suggests harnessing these obstacles and cognitive conflicts as levers for learning.

Projects involving pedagogical collaboration between students living in distinct contexts offer very rich intercultural situations. They create opportunities for individuals to encounter and be confronted with different cultures, and for exchanges to take place with respect to conceptions. Such situations can lead to the emergence of phenomena of particular socio-cognitive conflicts called context effects (or CEs) through their close connections to contexts. They aim to enable the co-construction of richer conceptions regarding the object under study, through an understanding of cultures and contexts other than the learner's own culture and context (Fécil, 2014; Forissier, 2019; Merlo-Leurette & Forissier, 2009).

The notion of context is already very evident in the teaching of science (Schwartz et al., 2004), languages (Blanchet et al., 2009) and other disciplines (Tessmer & Richey, 1997; Zimmermann et al., 2007). Approaches known as didactic contextualization (King, 2012) are centered on the natural contexts of students as a motivating factor. Such approaches allow for authentic and stimulating teaching (Schwartz et al., 2004). A contextualized instructional approach in this field emphasizes the application of science as a way to improve the scientific understanding of students in the real world, while developing their abilities to function as responsible actors in their daily life (Bennett, 2005).

The use of context for learning has proven to be effective, particularly in EBEC (Anjou, 2018; Forissier, 2019). Such approaches are based on collaboration between classes from two distinct contexts, working on the same project involving a same object under study that can be perceived very differently according to the context in which it is studied. In context effect-based instructional approaches (EBEC), the learners in each context are

organized into several small teams of peers working together on a subtheme related to the project in various disciplines. Each team is involved in a context-based investigation. This means that Team A in Context 1 and Team A in Context 2 carry out an investigation in their own context on the same subtheme, and that they communicate and collaborate in order to achieve a common goal. The investigations are inspired by the scientific inquiry method (Cariou, 2002; Schwartz et al., 2004) and involve the learners in a process where they are invited to formulate questions and hypotheses which they then attempt to answer through observations or other means of data collection that are relevant to the given context. The objective is to enable the students to establish stable contextual knowledge on the object or the theme under study, and the aim of the collaboration is to have them share their conceptions and potentially to create a clash leading to the construction of a multi-contextual vision of knowledge.

Context effect-based education (EBEC) was initiated in environmental field with a naturalistic approach, in order for learners to be able to lead an authentic investigation (Schwartz et al., 2004) in nature and to observe their environment, and then to share it with learners in another context. But experiments in the field have shown that a clash of contexts can also be produced in other disciplines, such as history, culture, or areas of science and technology. On the basis of these preliminary findings, it was proposed to trial this pedagogical model in the vast area of SD, and this was then implemented.

Context of the Experiments

Most of the pedagogical experiments based on the context effects model were carried out as part of the Educational Technology for Contextual Teaching (TEEC) Project (https://teec.teluq.ca). This project uses Design-Based Research (DBR) methodology (Bourdeau, 2017), making it possible to bridge the gap between laboratory research and field research, and allowing for theory and practice to develop together through a design process.

In this study, using DBR methodology, a pedagogical model could be developed and tested through multiple field experiments allowing for one or more parameters to be set: the age of the learners, the theme or object studied, the learning scenario, activities, collaboration between teachers and the researcher, and data collection and analysis. The results of each experiment had to be taken into account in order to improve the next experiment, according to the lessons learned.

For the requirements of this article, we are using the term "experiment" to mean the procedure that consists of designing a pedagogical scenario as well as collecting data in the field, called an "iteration" in DBR methodology. The pioneers in the field spoke of "design experiments," (Brown, 1992). This is therefore not a case of experimentalism, which requires controlling the variables, but rather one of testing the value and effectiveness of a pedagogical design when it is implemented in the field, with the idea of improving this design, along with the data collection mechanism.

One of the goals of the TEEC Project is to demonstrate the robustness of the conceptual model of context effect-based learning with students of various ages and in diverse disciplines, particularly in the sciences, but also in history and in literature (Chartofylaka et al., 2019). Within this framework, two experiments with ESD goals were put in place between Quebec and Guadeloupe. The first addresses the theme of sugar, in particular the themes of sugar cane and maple syrup, and the second deals with fruits, involving the specific themes of bananas and apples.

The themes chosen for the experiments were selected based on their importance in the cultural contexts of the places concerned. Indeed, the maple tree is deeply embedded in Canada's culture, so much so that the maple leaf was adopted as the country's symbol and it appears on the national flag. Canadians are very proud of this resource. Quebec is the world's number one producer of maple syrup (95% of the maple syrup worldwide is produced in

Quebec) and exports it throughout the world. While the maple tree is highly important for the country's industry and economy, maple syrup production faces the challenge of climate warming, which has an impact on the production of maple sap. Apart from maple syrup, Quebec is also a large producer of apples. The province has more than 500 apple growers throughout Quebec, and this fruit is very popular with the local population, as well as with families who pick apples together in the fall. A small part of the production is exported to the United States and to other Canadian provinces.

In Guadeloupe, the banana and sugar cane industries are also very well anchored in local culture. Sugar cane was introduced on the island in the 17th century and played a crucial role in the island's colonial history and its history of slavery. Today, sugar cane is primarily grown for the production and export of rum, which is an integral part of the cultural heritage. Bananas were introduced in the 20th century and are now largely cultivated for local and international export. The intensive continuous cropping of bananas has caused a great deal of environmental damage on the island. It is enough to recall the great controversy surrounding the toxic pesticide chlordecone, which has been used for many years to the detriment of human health and farmland, and has also had an impact on the aquatic ecosystem and on drinking water (Crabit et al., 2016).

Introducing these themes into ESD pedagogical experiments offers a valuable opportunity to include cultural and intercultural dimensions into learning.

Conduct of the Experiments

Two pedagogical experiments were put in place based on EBEC methodology. They are part of the TEEC Project, that is, they were carried out in collaboration with researchers from the different organizations and universities in charge of the project (including the Centre de Recherches et de Ressources en Éducation et Formation (CRREF), the Unité de Recherche Intersectorielle en Informatique Cognitive et Environnement de Formation (LICEF), the

Équipe de Recherche en Éducation Scientifique et Technologique (EREST) and Université TÉLUQ) on the one hand, and the teachers and educational institutions on the other hand. The participating classes were recruited on a voluntary basis among teachers. These experiments were conducted with classes from Guadeloupe and from Quebec, on the common theme of "Sugar" for the first iteration, and "Fruit" for the second. These themes were addressed through pedagogical scenarios related to environmental problems. Both experiments required instructional and technical support, as well as a researcher for each one, and several communication tools: Zoom[1], for synchronous discussions by video conferencing, and the Edmodo[2] educational platform for asynchronous exchanges and document sharing. The teachers who agreed to participate in these experiments were involved both in preparing them and carrying them out. Data collection was made possible by the granting of an ethics certificate by Université TÉLUQ. A letter of invitation was sent to the parents and the children to obtain their consent to participate in this study and to be able to use the data collected. A detailed description of the experiments is presented below.

"Sugar" Experiment

The "Sugar" experiment involved 9- and 10-year-old students, corresponding to Grade 4 in Quebec, and CM1 (intermediate class 1) in Guadeloupe: 26 students from La Mennais School in Mascouche, Quebec, and 23 students from Pombiray Primary School in Saint-François, Guadeloupe, with their respective teachers. The instructional project lasted for three months, from February to April 2018.

The first step of the experiment consisted of a preparation phase involving the collaboration of actors from both schools for the technical organization and parameters for the

[1] Videoconferencing tool: https://zoom.us/

[2] Global education network: https://new.edmodo.com/

recordings, the consistency of pedagogical content, the learning scenario, teaching and sharing of activities, and for synchronization between Guadeloupe and Quebec. This step lasted nearly 4 months.

A first videoconference was organized during which all of the students had the opportunity to introduce themselves to the other group, and to present a short sentence describing their school or their local context (geography, tradition, climate, food, activities, etc.).

Next, the students from the two schools were divided into six teams working on six (6) subthemes: history/culture, biology, agriculture, the economy, health and the environment. A team for each context was assigned to work on a specific theme, and each team was involved in a scientific investigation in their local context. The procedure consisted of formulating questions connected to the theme (history, biology, etc.), on sugar cane or maple according to the context, and then to answer these questions through different activities and using the Internet, media and books, and finally, to produce a compilation of data in the form of posts, with a short presentation.

In Quebec, three activities were organized for the students to learn more about maple syrup:

- a visit to a sugar shack[3], where the process of collecting maple sap and transforming it into maple syrup was conducted. The students were invited to drill holes in the tree trunks (tapping) themselves and to install the pails for receiving the maple sap, so that they could better understand this process. They also participated in the testing of the various maple products (maple sugar, sugar loaf, maple butter, etc.). The maple producer explained the history of maple syrup to them and how it was discovered, as well as the biological phenomenon that enables liquids to flow in the tree.

[3] Video recording of the visit available at https://datamulus.licef.ca/index.php/s/JdwB77JBF8458MN

- a presentation to the students by a nutritionist, who explained aspects of food and health, and how they relate to maple syrup.
- a presentation by a research scientist specialized in forest ecology and climate change, who discussed how global warming is affecting maple forests and maple syrup production.

In Guadeloupe, two activities connected to sugar cane were organized:

- a visit to a sugar cane plantation housing a rum distillery and a creole garden, with a tour in a small train (Domaine de Séverin). During the visit, specialists explained the rum manufacturing process.
- a visit to two sugar cane plantations (Mahaudière and Néron) with a heritage curator, who explained the history of sugar cane, how it was imported, and its connection to slavery and colonization.

During the activities, the students had the opportunity to ask the speakers questions related to their investigations; they were also responsible for making video recordings, taking photographs and taking notes to be shared with the students from the other context.
The goal of the exchanges was to have students look at the ways in which students from another context approach things, to give them new ideas for questions, to motivate them to find answers, and to confront them with global problems through the various themes. The students could also exchange messages, photos and videos using the Edmodo educational platform. At the end of the experiment, they also sent each other gifts (samples of maple sugar and sugar cane).

"Fruit" Experiment

For the "Fruit" experiment in Quebec, the teacher who participated was the same one who was involved in the "Sugar" experiment, and 26 students from La Mennais School in

Mascouche participated. In Guadeloupe, 23 students from Amede Fengarol School in Capesterre-Belle-Eau participated in the project, along with their teacher. The preparation and instructional design phase began in April 2018, and the pedagogical experiment started in September 2018 and lasted for five (5) months, until January 2019. The aim of this experiment was to focus more on SD issues, and to improve the project design by giving the teachers specific suggestions for activities, questions and content pertaining to each theme. This experiment began with a presentation about the project and the meaning of SD, facilitated by researchers who are familiar with SD in Guadeloupe and in Quebec. In order to promote interactions between the students, during this experiment, the students were invited to answer a common question: "Which of the two fruits (apple or banana) is the best one for sustainable development?" A first videoconference with the two groups was put in place for the students to introduce themselves and to present a short sentence about the school or the local context. Similarly to the sugar experiments, classes were organized into six teams investigating six themes: in Guadeloupe, on the subject of bananas, and in Quebec, on apples, with respect to biology, agriculture, culture and history, health, the environment and the economy. A first series of videoconferences between the teams was organized to enable the students to introduce themselves and get to know each other. Next, two additional series of videoconferences between the students were put in place: the first, to exchange questions and hypotheses, and the second, to present the information collected during the investigations and visits, and to give the answers to the questions from the previous videoconference. At the end, a last videoconference providing the overall findings of the experiment was organized for the classes to present their final products.

In Quebec, a visit to an apple orchard with apple picking was organized. In Guadeloupe, the students discovered the peculiarities of the banana during a visit to the CIRAD (International Center for Agricultural Research for Development) and to a banana

plantation. During the visits in both contexts, experts in areas related to the objects under study provided explanations to the students.

Data Collected

Different data collection tools were developed and used for the experiments (Table 2). Video recordings of the exchanges and activities were collected, as well as pre-test and post-test questionnaires on students' conceptions (concerning sugar cane and maple for the first experiment, and apples and bananas for the second one). Notes and jottings about the organization of the experiments were also gathered, as well as video recordings of the many meetings between teachers and researchers. We also interviewed the teachers after the experiments. These interviews provided us with information about how the project was organized with the students, as well as a detailed follow-up of the experiment when the researchers were not present (apart from the Zoom session and activities).

Table 2. List of data collection tools and volumes of data collected for each of the experiments

Nature of the data	Sugar experiment	Fruit experiment
Video recordings of exchanges between groups	*2 sessions: 85 minutes*	*2 sessions: 170 minutes*
Video recordings of exchanges between teams	*3 sessions: 148 minutes*	*6 sessions: 440 minutes*
Video recordings of activities	*5 activities: 198 minutes*	*2 activities: 7 minutes*
Posts on Edmodo platform	*75 posts*	*34 posts*
Students' production	*1 report, 2 poster, 2 poems, 1 photo album, 4 slideshows*	*137 photos* *5 video clips (7 minutes in total)* *11 slideshows (learning object)* *1 slideshow for presentation*
Pre-test questionnaires	*23 for Guadeloupe / 26 for Quebec*	*21 for Guadeloupe / 25 for Quebec*
Post-test questionnaires	*23 for Guadeloupe / 26 for Quebec*	*21 for Guadeloupe / 26 for Quebec*

Organization documents	*Minutes of 4 meetings, video recordings of 2 meetings, ethics certificates (teachers and students), 2 descriptive documents of activities and themes congruent in both contexts*	*Minutes of 3 meetings, ethics documents (teachers and students), 1 provisional timetable with activities and content, 1 slideshow on SD*
Video recordings of interviews with teachers	*2 interviews: 1 with the teacher from Quebec, and 1 with the teacher of the Sugar experiment from Guadeloupe: 80 minutes in total*	
Teacher production	*1 report regarding the experiments from the Quebec teacher*	

The data collection was organized according to the problems addressed and the aims of the TEEC Project, which could change and evolve, to the extent that DBR methodology allows.

Accordingly, the data that were analyzed in depth here was not initially collected for the purposes of the problems addressed by this article. It was collected to meet the theoretical and experimental expectations of the TEEC Project, that is, primarily to validate the conditions for the emergence of context effects. However, the authors quickly observed that the "Sugar" and "Fruit" experiments brought together optimal conditions for studying the connections between intercultural education and ESD. These experiments made it possible to study these relationships in an original way: through pedagogical experiments.

Thus, not all of the data collected during the experiments are analyzed in detail, but specific examples taken from the video recordings, pre-test and post-test analyses, and interviews of the teachers contribute to illustrating how interculturality complements education for sustainable development.

Results

Intercultural Project-Based Learning as a Motivating Factor

During the first synchronous exchange, the students were asked to prepare something of their choice about their context or culture to present to the other group. Most students prepared

small PowerPoint presentations on the history, geography, local traditions and customs and shared photos of the snow-covered school, of local landscapes, of fauna and flora, local dishes. The sharing of images, customs and traditions was motivated by the intercultural aim of the project and by the students' desire to provide elements to help the other group better understand their local context.

For the "Fruit" experiment, some students from Guadeloupe prepared local dance and music performances. One of the students performed a dance set to famous Syrian music, as she is of Syrian origin. A student from Quebec brought to class all of the winter equipment used locally to show her peers. These student initiatives were evidence of their involvement in the project, and of their willingness to make their peers understand the local culture, but also about their personal culture, that could be different from Guadeloupe or Canada. These initial exchange activities, allowed the students to gain knowledge about a culture and context that was different from their own. By participating in this activity, the students were able to improve their communication skills and become more comfortable speaking in front of their classmates and in other settings. Additionally, they became more interested in learning about different cultures and were willing to share information about their own culture in order to be better understood by their peers, which helped them develop empathy and self-awareness. In summary, this exchange experience provided the learners with an opportunity to develop intercultural social, behavioral, and cognitive competencies, which are important in ESD.

The cultural differences between the groups, during this first step, stimulated the students' enthusiasm from the outset of the project. Interviews with the teachers confirmed that, in both projects, the students remained enthusiastic throughout the project. Indeed, Figure 1 illustrates the words that the students in the "Fruit" experiment wrote at the end of the year when they were asked what they had enjoyed the most during the school year (Couture, 2019). The bigger the word, the more often it was mentioned. We can see that "the

Guadeloupe project" was, by far, the most enjoyable activity of the year for them. The intercultural facet may be an important factor in this result as the adjective used to refer to this project is "Guadeloupe," whereas it could have been "apple project."

Figure 1: Illustration of what Quebec students who participated in the "Fruit" experiment found to be the most enjoyable during the school year (Couture, 2019).

Context-Based Inquiry in Diverse Disciplines

The semi-structured interviews conducted with the teachers after the experiments made it possible to obtain feedback about the work related to the project, which was carried out in class in several disciplines. A multidisciplinary approach was followed in two ways: (1) the teams of each class group worked on different themes (agriculture, the economy, biology, the environment, etc.), and (2) the teachers from both groups and both experiments worked in several different disciplines according to the project's topic, in order, among other things, to provide students with the materials for their work carrying out research. For example, for the "Sugar" experiment, the teacher from Quebec used the project interactions as an opportunity to work on the basics of grammar: *"to see what a question is, what a sentence is, which words to put at the beginning, and how to use the question mark"*, so that the students would be able

to use this knowledge to formulate relevant questions for their peers. They also used this project to address concepts of geography, they *"explored a lot about Quebec, [...] saw that there isn't maple syrup everywhere and then […] tried to see why"*. They went into the literature and history field by studying "*about maple syrup legends with Indigenous peoples"*, and in science, they: *"learned about […] simple machines, the basics, tailboards, wheels, [...] the hammer, gimlets, […] the tools that"* they used during the sugar shack visit. In art, the teacher explained that they *" made maple trees, […] and then,* [the students] *had to put aluminum foil bucket taps on them, and it was funny because they were putting them anywhere at all in the branches, until [*they*] said, 'Hey, is that where they should go?' and* [the students would reply] *'Oh well, no, it's true that they should be down lower"* (translated quotes from the interview with the teacher from Quebec).

In Guadeloupe, the relationship between sugar cane and the island's history, the colonial period and slavery was discussed in class and also during the visit to the Mahaudière Plantation (Anse-Bertrand). The cultural facet of sugar cane was used as a guiding thread for teaching the many dimensions of sustainability: its importance for Guadeloupe's economy, its effects on social organization, and its connections to ecological issues. Overall, the cultural anchoring of the object under study in this project was used as a contextualization tool in each discipline.

For the apple experiment, the Quebec teacher used the project as an opportunity to address topics related to various disciplines too: *"About apples,* […] *in the Ethics and Religious Culture class, [*the teatcher*] had seen something in the book by Madonna, it was hard to find that book, but [*she*] was really happy to have found it, it was no longer being sold, 'Mr. Peabody's Apples'"*. She also used the project to study *"the expressions about apples, that was great to work on, because they* [the students] *learned a lot,* [in terms of French expressions]: *'tomber dans les pommes'* [meaning 'to faint'], *'haut comme trois*

pommes' [meaning 'knee-high to a grasshopper'], '*une pomme par jour*' [an apple a day]*"*. She also "*took the opportunity to work on what a question is".* Then, when she bought apples in school, used them to *"work on fractions"*, she said she had *"24 of them"*, and asked the students to group them to have *"one third, one quarter"* and then *"made some wonderful applesauce"*. In sciences and biology the teacher and her students *"worked on the parts of apples,* […], *took photos* [of them], *tried to identify the* [different] *parts.* They *"also learned all about planting techniques, and the kinds of apples"*. As for the maple, the teacher addressed the history, colonialism and globalization when they *"discover*[ed] *that there were no apples initially in Quebec, they were imported and"* she said *"it was interesting to see all that was involved in this"*. In plastic arts, they *"did drawings in the style of Britto"*, they created *"apples with lots of images"*. Finally, in mathematics, they *"used different types of measurements […] grams, […] liters, [and] for measuring apples, centimeters"* (translated quote from the interview with the teacher from Quebec).

This effort made by the teachers might have helped the students to develop holistic thinking. The pre-test and post-test analyses brought to light the fact that students' conceptions became increasingly complex. Table 3 presents the results noted in response to the question asking students to name six words connected to fruit. The words given by the students were classified according to the field of reference of the word (name of fruit, word related to nutrients, processed products). We chose to illustrate the data by the number of students rather than in percentages, due to the small number of responses in some categories.

Table 3. Results noted in response to the question asking students to name six words connected to fruit.

Categories of words	Examples of words	Number of words	
		Pre-test questionnaire	Post-test questionnaire
Nutritional elements	Calcium, iron, vitamins, potassium	10	11
Plant elements	Tree, seed, peel, kernel, flower, pulp, plant	10	26
Transformed products	Juice, pie, medicine, salad	6	7
Food-related words	Food, taste, eat, lunch, to feed, beverage	11	5
Health-related words	Strength, energy, health, to grow	10	19
Nature-related words	Environment, compost, organic, pesticides	8	8
Descriptive adjectives	Fresh, good, sweet, juicy, big, tasty, chewy	5	16
Technical terms	Agriculture, transformation, exportation	0	4
Total diversified words		60	96
Total number of words of the following type: fruit names		193	161

Examples of fruit names: apple, banana, pear, mango, grapefruit, orange, lemon, kiwi, peach, strawberry…

In order to analyze the data collected for this question, we have grouped together the words of the "fruit name" type and the other types of words under a category called "diversified words." In the post-test analysis, we observed many more diversified words than examples of fruit names (60 diversified words in the pre-test questionnaire and 96 diversified words in the post-test questionnaire), and fewer examples of fruit names (193 examples of fruit names in the pre-test questionnaire and 161 in the post-test questionnaire). The analysis reflects the presence of words connected to the themes studied. In the post-test analysis, we noted different technical terms, reflecting increasingly complex conceptions, such as "exportation," "agriculture" and "transformation." We also observed more words connected to health and plants, as well as descriptive adjectives, showing the development of a richer vocabulary and a more complete representation of the fruit. The use of diversified word by students is an indicator that their representation and knowledge about fruit became more complex and has evolved, which may be due to the multidisciplinary approach used during the project.

Collaborative Learning in a Digital Environment

The class organization during the project made it possible to develop collaborative

competencies and values, such as solidarity and mutual assistance, as mentioned in the interview with the teacher from Guadeloupe (see the following translated quote):

> "The positive side is that the children are all united. At the beginning of the project, some of the students stand apart and at the end of the project, we notice that the groups are really well committed, they help each other, there is no 'I'm smarter than you,' I'm more gifted,' no no, they pull together in order to make a group production, they have understood what is at stake."

The two experiments also contributed to the development of interactional and communication competencies, which are crucial to collaboration. The exchanges with students from another context provided an opportunity for the students to apply and deepen these competencies, as the differences between the two contexts sometimes led to misunderstandings or disagreements requiring explanation, rewording, discussion or negotiation, as it is shown in Table 4.

Table 4. Example of exchanges between the students in two contexts in the "Fruit" experiment (SQ: student in Quebec; SG: student in Guadeloupe).

SQ3	do we pick bananas anytime we want?
SQ1	any season?
SG2	no
SQ3	what is the good season?
SQ4	for the bananas
SG2	in Lent
SG1	Lent
SQ4	eh, what is Lent?
SQ3	it must be their season or something like that
SG2	Lent is a hot season
SQ1	ah we call it Summer

In Quebec (which has a mainly continental climate), the seasons are summer, spring, autumn and winter. In Guadeloupe, where there is a tropical climate, there are only two seasons: a wet one and a dry one. The dry season is locally called "Carême" in French, which has been translated as "Lent," and the wet season is called "hivernage," which can be translated as "wintering." There is what is known as a context gap about the theme of the

seasons between Guadeloupe and Quebec. This gap is also cultural because the dry season corresponds to the period of Lent (a 40-day period of abstinence, in the context of the Christian Church, leading up to Easter weekend). As shown in Table 4, when the students from Quebec ask about the best season for the banana harvest, they do not expect to receive an answer related to a religious celebration. Indeed, they do not understand this to begin with. Then, once this has been clarified, they can relate the season of Lent to their summer. This is a relevant example illustrating how the contextual and cultural differences of students can result in enriched knowledge, but can also lead them to draw on rewording and listening competencies.

The videoconference sessions enabled the students to learn how to behave in front of the camera, in a team or in a group, and how to speak in front of their own class and in front of another class. In fact, during the first experiment (Sugar), the exchanges between the teams took place in the presence of a researcher or of the teachers. During the second experiment, some of the exchanges took place without an adult being present. The purpose of this was to allow for more spontaneous exchanges between the students. We observed that during an exchange between the teams working on the history theme, in the Fruit experiments, when the students from Quebec were particularly agitated, the students from Guadeloupe asked them not to shout in front of the camera and not to speak all together at the same time, as the Guadeloupe students could not understand what the Quebec students were saying. In response, the students from Quebec admitted that "they [the Guadeloupeans] are more mature than we are," and tried to change their behaviour in order to adapt to the interactional situation. This is evidence of self-awareness, which can contribute to developing the ability to adapt and the ability to change one's behaviour.

During the interactions, the students sometimes had to deal with linguistic variations and accents for the same language (French). For example, during one of the first interactions

in the Sugar experiment, a student from Quebec asked opposing team members if they put sugar only in cans, or if they could put it in other types of containers. She mixed up “cans” and “[sugar] cane.” In Quebec, maple syrup is generally found in a can, and she thought that sugar in Guadeloupe was also stored in cans, and that this is why it is called *canne à sucre* [sugar cane]. This led to a misunderstanding since, in Guadeloupe, the term “can” does not exist and is translated by “*conserve*.”

Before the videoconference session, the students had to prepare the content of the interaction. They prepared questions, presentations and a synthesis of the data collected during the inquiry. The interactive dimension/interactive tasks between the students motivated them to select a certain amount of relevant data about the learning task, to interpret this data based on different sources, and to assess the information’s relevance. This aspect helps to reinforce the acquisition of critical thinking and anticipatory competencies. The intercultural dimension of the instructional project enabled the students to boost/strengthen their involvement and to increase their interest towards the students from the other context by cultivating the values of respect and empathy.

Beyond the tasks associated with the interactions, curiosity about the context of the other group was a constant driver of discussions. Indeed, at the end of almost every videoconference session, in both experiments and during the times when the students were in small teams, off-task exchanges were improvised: *“Do you have Christmas?”; “What are your Christmas customs?”; “What games do you play during the breaks”; “What is the temperature?”; “Have you ever seen the snow?”*

The project was also a good opportunity for the students to become familiar with technological tools (videoconferencing, educational platform, and video and audio recording tools). The intercultural aspect was a motivating factor for the students because they needed this familiarity with the tools to share with their peers. The responsibility for sharing

experiences during the activities and visits (with photos, videos, and audio recording tools) with the students from the other group was taken very seriously, which strengthened their commitment and their abilities to use the technological tools.

All of these observations show how the contextuality and interculturality brought added value to the pedagogical model of context effect-based teaching for ESD, and especially for the development of the competencies related to this field.

Discussion and Conclusion

Summary of the Results

Based on the analyses that were done, we can establish that the projects carried out in the context of the pedagogical experiments contributed to the development of intercultural cognitive skills related to sustainability: knowledge of the local culture and of another culture (customs, traditions) and knowledge of environmental, economic and social issues related to the production of products in the local context and in another context. It also allowed the learners to develop behavioral and emotional skills mainly through exchanges (communication, collaboration, listening, empathy, adapting one's way of being in front of the other). The teachers and researcher’s willingness to carry out this project based on scientific and problem-solving methods and to approach it through educational entries in different disciplines allowed the learners to become familiar with holistic ways of thinking.

The advantage of our study is that it pertains to experiments that were not designed with the aim of developing specific SD competencies, but rather were put in place in different disciplines, using a methodology that provided considerable flexibility for research (Bourdeau, 2017). This made it possible to explore a number of data sets based on several methodologies and theoretical frameworks.

It is worth mentioning that, given that this is an exploratory study, the available data from our experiments do not allow for characterizing all of the competencies that are pursued and applied by the students (or by the teachers). Moreover, the competencies that are listed and illustrated in the study have not been evaluated, and it has therefore not been demonstrated that the project will have a long-term effect, or that these competencies pertain to all of the students who participated in this project.

Development of a Model for ESD Competencies through Context Effect-Based Education on Sustainable Development

By analyzing the experiments, it was possible to design a model that illustrates the development of intercultural competencies, in which intercultural interactions are the major feature and have therefore been positioned as a central element (Figure 2).

This educational model addresses key approaches for understanding diversity at various levels (personal, environmental, and cultural) that are indispensable for ESD. The use of cultural heritage, cultural diversity and interculturality as a foundation for constructing our ESD projects opened up an opportunity to begin developing a combination of interdependent competencies that can be classified according to four dimensions: (1) visions and thinking: the way in which students think and how they see the environment surrounding them (the impact of sugar cane industry in the development of the island for example); (2) knowledge: about the object under study but also digital and pluricultural knowledge (during the local investigation, and presentation given by the experts for example); (3) values, ethics and emotions, that we have gathered under the category of "being" and that are linked with the behavioral dimension (how to behave during the exchanges for example); and (4) process competencies that are linked to the notion of action and the use of tools (digital, manual, social, scientific and cognitive tools for example).

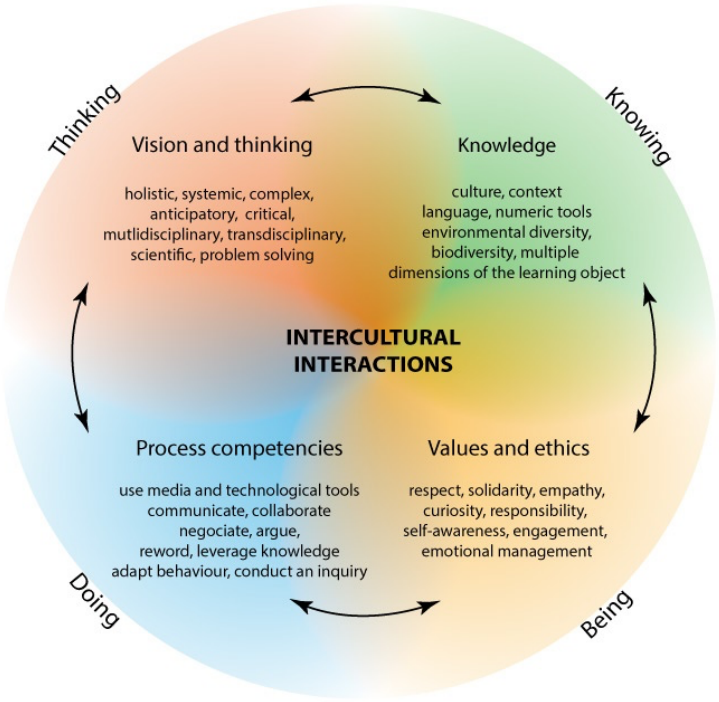

Figure 2. Schematic organization of the intercultural competencies developed in the "Sugar" and "Fruit" experiments.

These four dimensions align with the classifications that can be found in the literature on ESD (Cebrián & Junyent, 2015; Cebrián et al., 2020; Ministère de l'Éducation et de l'Enseignement supérieur, 2019b; Mulnet et al., 2016; UNESCO, 2005).

For example, the "thinking" dimension, shown in the top left-hand corner of Figure 2, is crucial for ESD; it enables students to develop a global, multidimensional, and multidisciplinary way of thinking, and a consistent way of approaching the problems, challenges and opportunities of sustainability. This dimension can be associated with what Wiek et al. (2011) call overarching competencies and is generally used to organize sub-competencies (Mulnet et al., 2016; UNECE, 2012; Wiek et al., 2011). In our experiments, the fact that teachers have integrated the project issues into various disciplines may have enabled students to develop this multidisciplinary vision. Moreover, the multiple themes investigated by the teams of students and the fact that they had to collaborate and produce common

answers and work have undeniably helped them to develop a multidimensional vision of the object under study. The problem-solving approach linked to EBEC methodology also contributed to the development of a particular way of approaching science. Lastly, the intercultural exchanges and collaborations with peers are a vector for improving critical thinking.

The “doing” dimension, shown in the bottom left-hand corner of Figure 2, includes process competencies that encompasses the ability of students to carry out the task; it corresponds to what Stier (2009) calls “processual competencies” and can be associated with key cross-curricular competencies for example. It can also be associated with the “practical” dimension used in Clément and Forissier’s KVP model (interaction between scientific Knowledge, Values and Social Practices) of environmental competencies (Clément, 2010; Forissier, 2003).

The “knowing” dimension, shown in the top right-hand corner of Figure 2, covers the content of the learning process pertaining to the object studied. It can be correlated with themes linked to ESD and to Sustainable Development Goals (SDGs), but also with knowledge that is not directly connected to the learning task. In our experiments, students' knowledge primarily concerned cultural and intercultural knowledge, but also such things as digital knowledge. Indeed, the students acquired knowledge about the apple and banana/maple and cane history as well as how they are culturally anchored in both contexts. They also gained knowledge about their biological and environmental characteristics, about how to grow them, and their impact on the local economy and on health. In addition to the knowledge acquired about the object under study, knowledge addressed in the context of EBEC also concerns the digital tools used, such as communication tools (Zoom and Edmodo) and some cultural traits of the other group (like traditional food and celebrations).

Finally, the "being" dimension, shown in the bottom right-hand corner of Figure 2, including values and ethics, pertains to how the students behave and interact with each other. It contributes to the development of intrapersonal and interpersonal skills. This dimension is often cited as such in studies about ESD (Cebrián et al., 2020; Lozano et al., 2019) and is essential to understanding the social dimension of sustainability. The "being" dimension is key for addressing clashes of values, ethics and emotions related to ESD in a concrete situation. In our experiments, social and behavioural competencies were required for interacting with peers and also for knowing how to behave.

All of these dimensions are interconnected, and it is not as easy to classify each competency within a single dimension. Each learning task or action can lead to the development of multiple facets of competencies, in multiple dimensions. Negotiation between the teams to find the best fruit, for example, enabled the students to develop interactional and communication skills, and to leverage the knowledge acquired in multiple disciplines, such as knowledge about environmental and health effects. Such negotiation fostered strategic and anticipatory thinking, but also respect for others, self-control and engagement, thus contributing to critical thinking. It also enabled the students to discuss and address the knowledge and conceptions of the other students. The inclusion of two distinct cultures, which is the foundation of the Context Effect-Based Education (EBEC) pedagogical model, played a key role in the development of key overarching competencies in diverse disciplines (Chartofylaka, 2020), particularly in ESD.

Contribution to the Development of Teachers' Skills

From another standpoint, the project was an opportunity for the teachers to become familiar with the concept and competencies of SD. The teacher from Quebec admitted that she was a total neophyte regarding SD; she stated that she has learned a lot about SD through the project. Despite the complexity of implementing such a project (synchronization in two

contexts, digital and multimedia equipment, concordance of pedagogical scenarios, and organization of activities), the teachers showed real enthusiasm for the project and drew great satisfaction from it.

Beyond raising awareness about SD, the project contributed to diversifying the pedagogical competencies of the teachers, in accordance with ESD. For example, the collaboration between teachers from two different cultures, and between teachers and researchers, was key for developing ESD competencies. In fact, while interculturality is fostered by the interactions between students from different cultures, it is essential and valuable for teachers to interact in a similar way, not only to ensure the proper conduct of the project, but also to serve as good role models. Teaching SD is a complex task—the subject is often included as a concession within the curriculum, and there are generally no concrete demands supported by the educational institution. In addition, due to the novel nature of institutional and political demands, teachers often lack the necessary skills to teach SD (Bertschy et al., 2013; Clément & Caravita, 2011). And even if some of them are sensitive to and aware of this field and have the relevant knowledge, they might not understand the complexity and diversity of the competencies, visions and values as an overall and interconnected set of attributes. The use of our model, as shown in Figure 2, could help teachers develop their understanding about competencies and complexity of SD and its attributes.

General Conclusion

In response to our research aim, the intercultural dimension of our "Sugar" and "Fruit" experiments made it possible to gain a more in-depth understanding of many and diverse ESD competencies, both with learners and with teachers. In addition, the cultural anchoring of the objects studied and their relationship to local contexts helped to stimulate intercultural interactions, which were a driver for engaging and motivating students during the project. By

adopting an intercultural approach in instructional sessions about sustainable development, it became possible to transcend school boundaries, thus providing an opportunity to consider and reflect on the effect of interculturality in ESD learning.

Although, the experiments conducted using EBEC were put in place with the initial aim of teaching students about sustainable development and by positioning context as the central element, can be equated with intercultural education as described by Blanchet and Coste (2010), and Dumont (2008).

Like the latter, EBEC is constructed in a way that allows learners to go through multiple stages of contact, meeting, syncretism and synthesis with learners from the other context. Furthermore, intercultural education, like EBEC, does not follow a linear learning path, but is made up of moments of divergence, fear of otherness, lack of understanding, tension and even conflict facilitated by the context effect-based specific instructional approach. In fact, such moments of cognitive and socio-cognitive conflict are pursued in context effect-based approaches.

Based on our findings, practicing intercultural education is practicing education for sustainable development because culture considered as a pillar of sustainable development and interculturality is a major aspect of sustainable development and education for sustainable development (Clément, 2011; Kadjiannopoulos, 2020; Tilbury et al, 2009).

Education for sustainable development benefits from integrating interculturality since, even though interculturality is not often addressed in ESD practices and may seem complex to integrate, interculturality allows the development of well-established ESD competencies such as understanding others, respect and empathy.

On the one hand, EBECs are based on a bicontextual and bicultural structure. Interactions between teachers and learners from different cultures are the primary challenge, but also the mainstay of EBEC. Implementing an EBEC-based pedagogy is ultimately

practicing intercultural education. On the other hand, EBECs are organized according to a structure that is consistent with ESD because of their multidisciplinary, problem-solving aspects, and the development of various skills that are also associated with ESD such as communication, digital and project skills. Both of these aspects illustrate how EBEC pedagogy have proven to be a facilitating mean of integrating interculturality into ESD.

Finally, implementing our experiments in both Quebec and Guadeloupe fostered open-mindedness in learners and teachers regarding cultural diversity and also provided them with tools to better understand their own history and culture. In addition to associating two cultures and enabling learners and teachers to become familiar with the culture of their peers in another country, EBECs encourage them to reflect on the consideration of plural cultures and thus to develop a more global understanding of the problems posed and their possible impacts.

In conclusion, integrating intercultural education with education for SD is key to nurturing a just, balanced, and resilient future for our planet. By fostering cross-cultural understanding and collaboration, we can build inclusive societies and pave the way for a sustainable future grounded in shared values of environmental stewardship and social equity. This interconnected approach is crucial for creating a harmonious and resilient world.

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