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► **To cite this version:**

Lamprini Chartofylaka, Thomas Forissier, Charline Lefort, Célia Obertan, Antoine Delcroix. Collaboration for Sustainability Education in the Lesser Antilles: The Formalink Project. CAS23-2023 Conference on The Sustainability and Development Initiatives of the Caribbean, Nov 2023, St Augustine, Trinidad and Tobago. hal-04326342

**HAL Id: hal-04326342**

**<https://hal.science/hal-04326342>**

Submitted on 6 Dec 2023

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**THE CARIBBEAN ACADEMY OF SCIENCES**  
**23RD BIENNIAL CONFERENCE 2023,**  
THE UWI, ST. AUGUSTINE CAMPUS, TRINIDAD AND TOBAGO

*hosted by*

**The CAS Trinidad & Tobago (CAS-TT) Chapter**

**24th–25th November, 2023**



**THE CAS23–2023  
CONFERENCE ON**  
*“The Sustainability  
and Development  
Initiatives of the  
Caribbean”*

**CONFERENCE  
PROCEEDINGS**

**#CASConf23**

**ISBN 978–976–620–306–1 (Print)**  
**ISBN 978–976–620–307–8 (e-book)**

*Proceedings of*

The CAS23-2023 Conference on  
The Sustainability and Development Initiatives of the  
Caribbean

24th – 25th November 2023

Faculty of Engineering  
The University of the West Indies  
St Augustine  
Trinidad and Tobago

Edited by:  
Kit Fai PUN

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ISBN 978-976-620-306-1 (Print)

ISBN 978-976-620-307-8 (e-Book)

### The Conference Colours

Yellow, Purple, Green and Blue which run throughout the heart of the conference, seek to represent the following:

**Yellow** - This represents the colour of the Caribbean Academy of Sciences logo.

**Purple** - This colour represents the ‘purple economy’. This type of economy or economic development is multidimensional and multidisciplinary in its approach. It considers key social issues that have a profound impact on the quality of life for Caribbean people. The purple economy seeks to move away from the traditional measures of a nation’s wealth such as Gross Domestic Product (GDP), to include the following areas: maternity leave, life balance, flexible work arrangements and gender pay gap. This last issue is explored at the 23<sup>rd</sup> Biennial Conference. The purple colour therefore represents a Caribbean economy that champions the livelihood of our people.

**Green** - This colour embodies the concept of continuous growth and renewal. It therefore simultaneously represents the dual desire for more development in the Caribbean, as well as development which is sustainable in its focus.

**Blue** - This colour is linked to the blue economy but from another perspective it represents the waters that bond us together. The Caribbean Academy of Sciences (CAS) 23<sup>rd</sup> Biennial Conference, provides an opportunity for us to gather and work together to fuel the “**Sustainability and Development Initiatives of the Caribbean.**”

- Designed by: Albertha Joseph-Alexander PhD

## Collaboration for Sustainability Education in the Lesser Antilles: The Formalink Project

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**Abstract:** *This paper highlights elements of an educational experimentation (project Formalink) carried out between 2022 and 2023 and focused on the theme of managing water in a sustainable way. It involved primary school students (aged 8-11 years) based in Guadeloupe and Saint-Barthelemy. Despite being geographically close, these two insular areas have notable variations in social, economic, and ecological aspects, also evident in the realm of water resources and management. Using a contexts-effects-based approach, children investigate their respective environments and share their findings on the matter through collaborative work with their peers in a virtual collaboration setting. In this paper, we begin presenting key elements on how teachers from different parts of the Lesser Antilles manage to orchestrate the instructional scenario and the experimentation. We then, by analysing data from interviews with the teachers who participated, identify three aspects (cognitive, affective, and behavioural) of this interregional collaboration that fostered science learning for sustainability during the project.*

**Keywords:** *Education for sustainable development, collaboration, scientific learning, contexts-effects, Guadeloupe, Saint-Barthelemy*

### 1. Introduction

The Sustainable Development Goals (SDGs) agenda encompasses a wide range of goals and targets that highlight the importance of developing educational initiatives to enhance learners' understanding of sustainable practices and promote their overall well-being (United Nations, 2015). With an interest in interregional collaborations for environmental and sustainability education in the Caribbean, this paper shares insights and findings of an educational experimentation on the scientific object of sustainable water management, conducted with primary school students based on two French overseas territories in the Caribbean: Guadeloupe and Saint-Barthélemy.

### 2. Theoretical Framework

We start by introducing the conceptual framework of the context-effects-based model adopted during our experimentation and we address the collaborative aspect of engaging learners from different parts of the world to study the same scientific object in distance.

#### 2.1 Contexts-effect-based and Scientific Learning

Previous studies (Giamellaro, 2014; Van Oers, 1998; Vosniadou, 1992) have emphasised the importance of taking into consideration the dynamic and evolving nature of context, meaning the circumstances and the surroundings that teaching and learning situations take place. This didactic contextualising process can promote a deeper understanding of learning content by engaging all of the learner's senses (Giamellaro, 2014) and can constitute a source of motivation and commitment as well for students to learn science objects (King, 2012; Potvin and Hasni, 2014).

Contextualisation, according to Giamellaro (2014), can be thought of as a learning approach categorised as either primary (learning in context) or secondary (learning with context). The first one involves making sense of a given context through learners' direct experience with their environment. The second one aims to make connections between context and learning content using the indirect communication of experiences from other observations, case studies or in virtual environments. This didactic process finds support across multiple disciplines such as language sciences (Blanchet, 2009) and sciences and technology (Delcroix et al., 2013)

Differences among contexts, encompassing ecological, social, cultural, economic, or other factors, can lead to the emergence of what is commonly referred as contexts-effects. These effects can manifest (a) either by a gap between a conception carried by an individual and an observation of reality or of the environment which surrounds him/her or (b)

either by a gap between the conceptions of two or more people manifesting themselves during interactions in collaborative sequences (Anjou, 2018; Forissier, 2019).

To explore similarities and differences when learners study the same phenomenon or scientific object, pedagogical scenarios are designed to promote the emergence of context-effects (Forissier et al., 2013). Prior research has shown that the context-effects-based approach can stimulate conceptual change within a discipline (Anjou, 2018; Chartofylaka et al., 2018) while also fostering the development of additional skills like digital and intercultural competences (Chartofylaka et al., 2021; Stockless et al., 2021).

## 2.2 Collaboration in Distance Settings

Collaborative research in education, which brings together researchers and teachers in fieldwork, has proven many advantages in enhancing scientific inquiry experiences for students (Desgagné, 1997; Savoie-Zajc, 1999). The social and collaborative aspects of knowledge construction and sharing among individuals has been revitalised and renewed using digital technology (Aillerie and Favre, 2014). In fact, within the field of computer-supported collaborative learning (CSCL) a comprehensive meta-analysis conducted by (Jeong et al., 2019) states that: “CSCL experience had the largest effects on the students' learning processes but also showed effects on learning gains and affective outcomes such as motivation, self-efficacy, and attitude toward STEM [Science, Technology, Engineering, Mathematics] domains.

Learning taking place in both asynchronous and synchronous environments enables students, from different parts of the world, to actively immerse themselves in discussions (“constructive controversy”) with their peers as they work collaboratively to reach a consensus on a specific issue (Johnson and Johnson, 2009). Through these interactions, they create an opportunity to bridge their thoughts and mutually enhance each other's understanding (Henri and Lundgren-Cayrol, 2001) when they compare their respective contexts by using in their discourse words such as “we” and “you” (Le Bail et al., 2021).

## 3. Presentation of the Case Study

The data presented in this paper were collected as part of a pedagogical experiment conducted under the framework of a larger research project entitled Formalink (Forissier et al., 2020). The Formalink project focuses on the implementation of instructional scenarios around sustainable development and its three pillars (social, ecological, economic) among students at various academic levels within the academic region of Guadeloupe (Guadeloupe archipelago, Saint-Martin, Saint-Barthelemy). Two classes, based in different parts of this region, study together the same phenomenon or scientific object, by using synchronous and asynchronous communication tools. Instructional scenarios are developed around a “Socially Acute Question” (Legardez and Simonneaux, 2006). Firstly, the project includes fieldwork and documentation research conducted in both classroom settings and outdoor environments, in addition to small-group discussions as suggested by (Aronson et al., 1978). Secondly, learners collaborate virtually to share their findings, engaging in both synchronous and asynchronous activities.

The context-effects-based experiment, conducted between January 2023 and June 2023, involved primary school students (aged 8-11) based in the community of Capesterre Belle-Eau (Guadeloupe) and Saint-Barthélemy. The shared study topic was “sustainable water management” and the classes were split into four groups, each focusing on a different subtopic: topography, treatment, waste reduction, and pollution. Learners engaged in exchanges through both synchronous (using Zoom application) and asynchronous (using Padlet application) discussions. Their primary objectives were to showcase the particularities of their respective contexts, delve into the issues they encountered, and collaboratively compare and contrast their research findings related to the topic: “How is water sourced and distributed for various purposes, including drinking and domestic use? (ie. harvesting, testing, processing)?”. The confrontation of their (external) contexts could result in the reinforcement of their knowledge.

Within a distance of 227 km, these two insular territories, parts of French overseas territories, hold many differences in terms of their colonial history, socio-demographics and current economic activities (Debedde-Georgel, 1998; Deveau, 1972). Concerning their ecological context, Saint-Barthelemy, on the one hand, is a small, dry and arid island lacking natural water sources. Traditionally, residents used to harvest rainwater and preserve it in water tanks for their daily needs - practice they continue to uphold in the present day. Water is produced by the desalination process by reverse osmosis in the seawater desalination plant that exists in the island. As a luxury tourism-oriented island, the demand for water experiences substantial growth during the peak tourist seasons. On the other hand, Capesterre Belle-Eau is a community situated in the mountainous and volcanic part of Guadeloupe, Basse Terre. It has a rich biodiversity of flora and fauna and many rivers and waterfalls with the most famous being Carbet Falls located in the National Park of Guadeloupe. Despite the abundant natural water resources (rivers, groundwater), ongoing issues within the water distribution network have resulted in very frequent water shortages for residents. As a result, many households keep water reserves in water tanks or bottles for their domestic use when they are out of running water. Capesterre Belle-Eau,

a community in Guadeloupe, is known for its large-scale banana plantations. This agricultural sector is associated with the persistent chlordecone health scandal in the Antilles, endangering both the well-being of the people and the environment until today (Ferdinand, 2015; Multigner et al., 2016).

#### 4. Methodology

In this paper we want to explore deeper the collaborative dimension for sustainability science learning during this experimentation. Therefore, we pose the question: “To what extent has the collaborative initiative within this interregional project facilitated students in gaining a deeper understanding of sustainability issues related to water in the Lesser Antilles?”

We examined data from interviews with the teachers (N=2) who took part in the experimentation with their classes. The interview grid was organised around nine key themes, which included exploring why they chose to participate in the project, their prior experiences with the scientific study topic, the skill and knowledge development of their students, and their thoughts on improving their teaching methods during this experience. Interviews, one lasting 54 minutes and 55 seconds, and the other extending to 80 minutes and 12 seconds, were recorded and initially automatically transcribed using the NVivo tool (QSR International Pty Ltd., 2020). Subsequently, the researcher in charge of this project fine-tuned the transcriptions manually. The “floating reading” method (Bardin, 2001) is used to explore thematically teachers' discourse, to study their overall meaning (Savoie-Zajc, 2000) and to create descriptive connections between their verbatim statements. Interviews were conducted in French and have been translated into English by the authors for the purpose of this article.

We draw upon the Community of Inquiry (COI) framework (Garrison et al., 1999), which emphasises three key elements in creating an enriching and compelling online learning experience. When effectively developed and coexisting, the following elements contribute to a collaborative-constructive learning environment: the social (engagement with participants), the cognitive (engagement with content), and the teaching (engagement with goals/directions) presences.

As this interregional initiative involves two classes from diverse cultural backgrounds, our analysis also incorporates elements related to intercultural competences. These encompass a range of cognitive, emotional, and behavioural skills and attributes (as described by the models of Chen and Starosta, 1996; Dirks, 1995).

#### 5. Results

We begin our analysis by pinpointing moments in the interviews when teachers mentioned the collaborative aspect with students from the other class: either in the context of synchronous sessions (indicating social presence) or when they encountered the findings shared by the other class on the asynchronous learning platform (indicating cognitive presence). These are instances (60 seconds on average) during their interviews where they discussed how they used and (re)direct cognitive and social presences to achieve meaningful learning outcomes for their students within the scope of studying a shared topic (teaching presence). The table below (Table 1) summarises the social and cognitive presences for each teacher during their interviews.

**Table 1.** Frequency of Occurrence of Social and Cognitive Presence in the Interviews Conducted

Frequency of Occurrence		Teacher 1	Teacher 2
	Social Presence	2	4
Cognitive Presence	4	1	

The following example illustrates one of the instances identified, starting with a triggering event (cognitive presence) that leads the teacher from Saint-Barthelemy to further explanation of the chlordecone scandal and soil and river water pollution and the (teaching presence).

*Teacher 1: “[...] We had chosen to make the students reflect on what are the threats to water, what type of pollution can you encounter locally? And so the answers were sometimes the same, but sometimes very different. And especially in Guadeloupe, children talked about chlordecone. We, in Saint Barth, when we received this [finding at the asynchronous learning platform], the children looked at me and said, “what is chlordecone?” [...] We spent the afternoon there [working on this topic], the whole history of this issue, and I think it was really one of the highlights of education for sustainable development in the project. It made a big impression on the children to understand that we could use products that are harmful to the environment, to all forms of life, to humans. [...] And that it is something that remains for a long time.”*



**Interviewer:** *So you weren't the one who brought up the concept of chlordecone? This is part of the findings shared to your class from students in Guadeloupe? They saw the word and they wondered what it was [chlordecone]?*

**Teacher 1** *Yes! And afterwards they asked me lots of questions, etc. We kept on working on that. But yes, it started as an element shared from children [of Guadeloupe] originally.*

(Interview Teacher 1, 17min 50 s – 18 min 59 s)

By using the COI framework to analyse these various interview instances, we identified three recurring thematic axes in teachers' responses regarding the importance of collaboration between classes from different parts of the Lesser Antilles working on a common scientific topic. We'll refer to Teacher 1 from Saint-Barthelemy as T1 and Teacher 2 from Guadeloupe as T2.

### ***Axe 1 (cognition): Collaboration to inform and raise awareness***

Both teachers (T1, T2) mentioned that initiatives such as the one described in this article help students to discover the geographical location of the places where they live, both in relation to the rest of the world and to each other. As learners from Guadeloupe were locating Saint-Barthelemy on the map, one of the questions that emerged was “whether Saint-Barthelemy is considered part of Guadeloupe” (meaning like other islands in the archipelago like Marie-Galante) (T2). Elements like this gradually emerged when children realized that they were going to work collaboratively with “peers who were not situated far away but rather within the Caribbean arc”. In any case, during the first synchronous session, students present their own contexts (territories, schools, and classes) to their fellow peers by using PowerPoints. This process allows them to visually explore the distant context and creates opportunities for “getting to know their classmates and engaging in discussions with children of their age” about aspects such as their lifestyle and shared interests (T2) and it was a positive experience because they did that “with respect, out of curiosity, actually” (T1).

When it comes to collaboratively studying a topic across two distinct contexts, on the one hand, T2 emphasizes the significance of their insular nature as a starting point for initiating research into the realm of water:

*“[...] We are on an island. Saint-Barth is an island too. So, starting from the notion of insularity. [...] How do we manage water? [...] How each island, each territory manages water or from the source to the tap? The path of water. [...] So there, I think we had that [insularity] in common. [...] And perhaps also, the topography do we find water in Saint-Barth? Where do we find water in Capesterre? And is it related to the island's specificity? Well, I think it's primarily about the territory, that is, starting from the insular territory...If we already have water on the territory, if there is water on the territory. And how is it managed...”*

On the other hand, T1 mentions that comparing two distinct entities has numerous benefits for enhancing children's understanding of a scientific phenomenon in its diverse aspects and variations. T1 emphasises that

*“The significant advantage, for me, is that the children have learned more than if they had simply learned within their single context [...] as there is no natural resource [in Saint-Barthelemy].”*

T1 also points out, as presented above, the contamination by chlordecone, which was brought up by the students of Guadeloupe in their publications on the asynchronous learning platform. T1 mentions that this information, in the context of comparing and contrasting their findings, allows her to raise awareness on protecting water resources and “[...] explain to them the importance of not polluting, that sustainable development is precisely what allows us to maintain the natural water cycle, and so on.”

### ***Axe 2 (affection): Collaboration to provide a “living together” experience***

When it comes to inter-class collaboration, T1 admits that “[...] there was a genuine willingness and impulse, both from my students and the students in Guadeloupe. This was evident during our videoconferences. They were very excited to work with another class and eager to do so. In fact, the children talked to me a lot throughout the year [...]”. This point is also mentioned by T2 who believes that “[...] video conferences, seeing each other, putting a face to a class, seeing the other [...]” - these aspects were motivating factors for continued participation in this experience. T1 also mentions that the interest of working with another context is also “learning to listen, to discover others [...]”, such as getting familiar with diverse accents among interlocutors. T2 states that participating in projects like the one described here can help learners to develop aspects of cross-cultural interactions as they learn about “[...] The existence of the other, with our differences and similarities”.

### ***Axe 3 (behaviour): Collaboration to develop a (pro)active attitude***



T2, during her interview, mentions that this kind of learning approach in which they have to share research findings with learners in distance:

*"[...] allows children to interact with each other, not just within the classroom. It gives them another perspective, another horizon, and the ability to inform each other. I mean, to conduct their research and then be able [...] present it to someone who is not in the same class or who doesn't know the neighbour who is not in the same environment". [...] You know, being able to express myself in front of children my age and also to share my research, what I found, to share and exchange on what I had discovered or already knew. So I think it motivates the students to think that I have a correspondent, and especially the notion of correspondence. I think at this age; they are very sensitive to the notion of correspondence."*

She adds that participating in this project can be very empowering for some students, when it comes to expressing themselves or being a part of a community and she explains that: "[...] some students have a limited vocabulary. They don't have lexical ease. [...] Some have difficulty expressing themselves. To express themselves at all. So through this project, it allowed them to gain self-esteem. To realize that they can work in a group, that they can present work with a deadline, with a given time, even if sometimes the time was too short. But working as a team". T2 explains that preparing work to present and participating in synchronous discussions with their peers can actually help some students get comfortable with speaking in front of a microphone or an audience, ultimately enhancing their oral communication skills. T1 points out that even though her 8-year-old students may not be able to express themselves as formally as adults, she believes that projects like this can encourage them to become more open-minded as they grow.

## 6. Discussion and Conclusion

In this paper, we emphasise the significance of fostering collaborative computer-mediated learning experiences among classrooms in the Caribbean, especially when addressing high related topics linked to climate change. Our research data originates from a pedagogical experiment conducted with primary school students (aged 8-11 years old) within the academic region of Guadeloupe. Our interest lay in exploring how the collaborative dimension of the project influenced their learning perspectives and a better understanding of the shared scientific topic. To achieve this, we conducted interviews with the two teachers, each participated in the project with their respective classes, and analysed their insights. Their statements showcase the potential of collaboration, within this contexts-effects-based approach, to make a difference in scientific learning and teaching in three key areas: (1) fostering geographic and environmental awareness; (2) enhancing cross-cultural learning and self-motivation; (3) facilitating oral expression and nurturing open-mindedness in young learners, cultivating essential attributes for future global citizenship.

Our study's scope is restricted due to the size of the participant sample (interviewees). However, their remarks on the collaborative aspect of the project offer valuable insights when considering how these experiences relate to connecting individuals from diverse cultural backgrounds to enhance education for sustainable development. To complete this analysis, a pedagogical guide addressed to the educational community is being prepared, providing insights on how to generate an instructional scenario within a contexts-effects-based education including different Caribbean contexts.

### Acknowledgments:

This study was conducted and received funding as part of the Formalink project - French Investment for the Future Programme 3 (PIA3).

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