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Abstract
This article presents three different cases of teaching and learning of science in a multi-lingual/cultural country (children from 5 to 9 years old). The three cases correspond to three areas of the science curriculum: our community, environmental protection and geology. In all three cases we made different but interrelated discoveries with special regard to Culturally and Linguistically Diverse (CLD) students, those who are more vulnerable concerning the learning of science at school. The first case showed how the translanguaging practices of CLD students assisted them in meaning making in a science lesson taught in Portuguese. The second case highlights the sudden and positive change in participation when a CLD student engages in hands-on science task, and the third case explores the development of another CLD student's participation during inquiry oriented science activities and examines the use of science notebooks as safe spaces. Taking these three cases together, this paper concludes that more "safe spaces", referring to the inclusion of languages and cultures of the students and inquiry driven science activities have numerous positive outcomes for CLD students in the primary science classroom.
Keywords: primary science education, CLD students, translanguaging, plurilingual students

Resumo
Este artigo apresenta três casos diferentes de ensino e aprendizagem de ciência em um país multilíngue / cultural (crianças de 5 a 9 anos). Os três casos correspondem a três áreas do currículo de ciência: nossa comunidade, proteção ambiental e geologia. Em todos os três casos, realizamos descobertas diferentes, mas inter-relacionadas, com especial atenção aos alunos culturalmente e linguisticamente diversificados (CLD), aqueles que são mais vulneráveis quanto à aprendizagem das ciência na escola. O primeiro caso mostrou como as práticas de transplantação de alunos CLD os ajudaram no sentido de fazer uma aula de ciência ministrada em português. O segundo caso destaca a mudança súbita e positiva na participação quando um aluno CLD se dedica a tarefas científicas práticas e o terceiro caso explora o desenvolvimento da participação de outros alunos CLD durante atividades científicas orientadas a inquéritos e examina o uso de cadernos de ciência como espaços seguros. Tomando esses três casos juntos, este artigo conclui que mais "espaços seguros", referentes à inclusão de línguas e culturas dos alunos e atividades científicas conduzidas por inquéritos, têm inúmeros resultados positivos para estudantes CLD na sala de aula de ciência primárias.
Palavras-chave: educação primária em ciência, alunos culturalmente e linguisticamente diversificados (CLD), translanguaging, estudantes plurilingues

INTRODUCTION

Culturally and Linguistically Diverse students and science learning

Culturally and Linguistically Diverse (CLD) students are a reality in schools in many parts of the world. It is a reality which is increasing as global migration increases as well. Often these CLD students find themselves in challenging situations, learning new languages and a new school "habitus", especially when they are newcomers to a community, a student category at great risk of school failure. In addition to newcomers, there are also CLD students who may be born in the host country, while their culture and language at home may be quite different

from the one at school. We believe that this constitutes an inherent richness in experiences and perspectives, as students learn to "navigate two worlds", however some school systems are not prepared for this richness and the institutional structures may not tolerate and value diversity in a systematic way. This may lead to a deficit view on CLD students,and even bring as a consequence a higher risk of school failure.

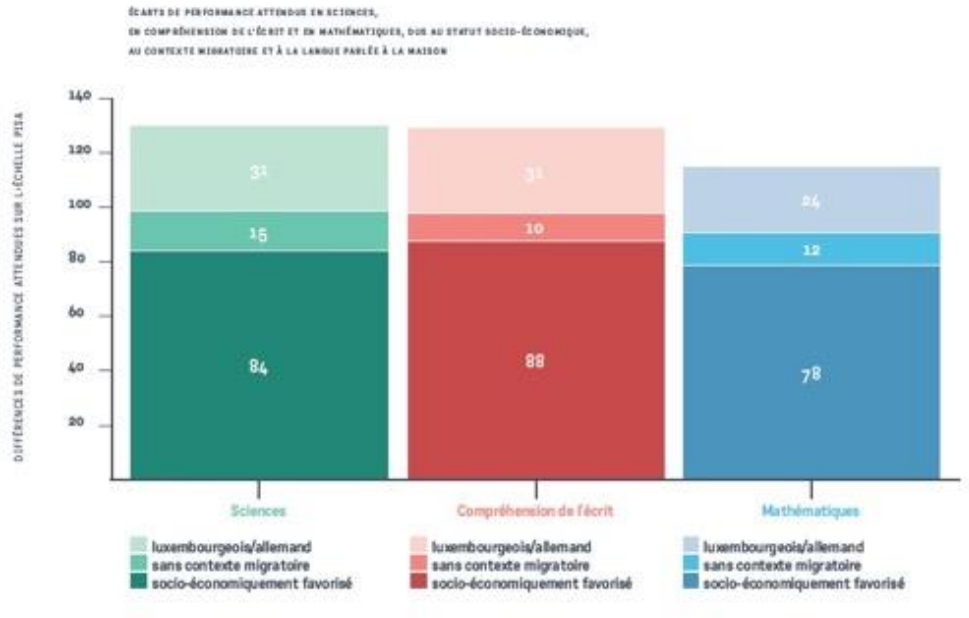
Our research is situated in the European country of Luxembourg, which has a trilingual public school system. Science is one of the key subjects in the primary school curriculum in Luxembourg, and it is to be taught in German, which is a foreign language for a large portion of the primary school students. While the official language of instruction for science is German, Luxembourgish still has an important place during the teaching and learning of science (FEHLEN, 2006), as allowed by the teachers. Other languages, most of them spoken at home by the CLD students, are usually not allowed by the teacher, although it is important to mention that in curriculum policy it is referenced that home languages out to be valued and recognised (see Plan d'Études, MENJE, 2011).

If we take the results of the latest PISA study (OECD, 2016), tests which take place when students are 15 years-old, one can quickly see a striking difference in performance of CLD students in science, and also in written comprehension, while slightly less in Mathematics. The results have been categorised by language spoken at home, migratory context (=CLD student) and socio-economic context. As we can see in Figure 1, and taking into consideration that the OECD mean score for science is 493 points, CLD students have an 84 point average of difference from their non-CLD peers (equalling two academic years of study). The socio-economic context is indicated as the main cause of difference in performance between students in science (shown in the green colored portion). The second reason for this difference in performance is the language spoken at home, with a 31 point difference between those speaking other languages at home than the languages of instruction; the third and final factor is the migratory context, with 15 points of difference between students who have recently immigrated to Luxembourg and their Luxembourgish peers. One of the possible explanations for this last distinction is that migrants may not know the school system as well as the locals, hence it is more difficult for them to progress in it, including in the discipline of science (MENJE & UNIVERSITÉ DU LUXEMBOURG, 2016).

The problem that often arises is that there are many CLD students who have a cumulation of these three factors: i.e., they do not speak Luxembourgish or German at home, their families have a lower socio-economic background, and they also have a migrant background. Therefore all of these three factors which have been found to hinder student

performance in science come into consideration regarding understanding their PISA performance.

Figure i. PISA 2015 results in Luxembourg (MENJE & UNIVERSITÉ DU LUXEMBOURG, 2016)



It is clear that "schools are one of the arenas in which people can work to change the existing distributions of power and knowledge in our society" (ERICKSON, 1987, p. 352), an important consideration for CLD students who are typically not at the top of the ladder and thus at risk of school failure in Luxembourg. As such, there is a need to better understand their day-to-day situation in the science classroom. By gaining deeper insights into this particular population we hope to increase understandings around the instructional needs of this group in order to better support their learning of science, an important facet of what is required for school success.

As we will explore further below, one of the ways to achieve this is by recognising the different capital students bring to the science classroom, which can be achieved in part by bridging the culture and language of the home with the one of the school: "No child should be expected to cast off the language and culture of the home as he crosses the school threshold, nor to live and act as though school and home represent two separate and different cultures which have to be kept firmly apart" (BULLOCK, 1975, p. 286).

The context of the SciPol:Lux project

Luxembourg, founding member of the European Union, is one of the smallest states in Europe. In spite of its size, it is currently the nation state having one of the most diverse populations in Europe. Luxembourg is unique and rich in its linguistic heritage; adding to the

great diversity of nationalities and languages (more than 170 in its territory) is the complexity of its three official (administrative) languages: Luxembourgish, German and French. According to the Eurobarometer, Luxembourg is the most multilingual country in Europe, with average citizens being able to hold a conversation in four languages (EUROPEAN COMMISSION, 2006).

The country of Luxembourg has a population slightly over half a million people (576.200), with almost half of these holding passports other than Luxembourgish (46 %), and these numbers are increasing (STATEC, 2016). A similar situation is evident in public schools, with up to 44,1 % of students having a nationality other than Luxembourgish (MENJE, 2016). Luxembourg is situated at the crossroads of three countries; France, Germany and Belgium. Its geographical situation has shaped its history, including the various belongings to several countries, until becoming independent in 1867 (PEPORTÉ et al., 2010). The linguistic structure of three official languages has emerged from geographical and historical reasons. It was not until 1984 that Luxembourgish was declared an official, and at the same time the national, language (LE GOUVERNEMENT DU GRAN-DUCHÉ DE LUXEMBOURG, 1984); before that date of official classification it was used orally, and thus was not a written language until 1984. By classifying Luxembourgish as its own language, governmental positions began to require the command of Luxembourgish, as well as the other official languages of French and German. As a result of the necessity of having a command of Luxembourgish, currently 92 % of the public sector employs Luxembourgish nationals (STATEC, 2016).

Figure ii. Map of Luxembourg including the main road and railroads[1].

[1] http://www.luxembourg.public.lu/en/cartes-du-luxembourg/01-cartes-du-luxembourg/index.html

The public discourse of the government towards diversity and the multicultural population is quite positive. Public relations and policy documents tend to describe Luxembourg as a "a great mix of nationalities and cultures, which is reflected in all aspects of society, whether in restaurants, the arts, entertainment, sports, etc." (STATEC[2]). If this is true, it is almost remarkable that although Luxembourg's population represents people from 170 countries, most of the migration comes from European countries.

Table i. Population Census at 1st January 2016 (STATEC, 2016, p. 11)

Population

Population structure Population censuses	1991	2001	2011 x 1000	2016[1]
Total population	**384.4**	**439.5**	**512.4**	**576.2**
of which: Women	196.1	223.0	257.4	287.1
Luxembourgers	271.4	277.2	291.9	307.0
Foreigners	113.0	162.3	220.5	269.2
of which: Portuguese	39.1	58.7	82.4	93.1
French	13.0	20.0	31.5	41.7
Italians	19.5	19.0	18.1	20.3
Belgians	10.1	14.8	16.9	19.4
Germans	8.8	10.1	12.0	12.8
British	3.2	4.3	5.5	6.1
Dutchmen	3.5	3.7	3.9	4.0
Other EU countries	6.6	9.2	21.5	32.1
Other	9.2	22.5	28.7	39.7
Foreigners in %	29.4	36.9	43.0	46.7

[1] estimation on January 1st

Diversity and the *lusoburguês* students

The Luxembourgish education system serves up to 90 % of the school population, with the remaining portion (approximately 10 %) of students attending private schools (MENJE, 2016, p. 73). The Luxembourgish curriculum has remained almost for almost a hundred years (WEBER & HORNER, 2008), although the student population has dramatically changed. A reform took place in 2009, introducing the evaluation for competences, the cycles, among others. However, the main characteristics of the system remained in place, for instance, the initial literacy instruction being in German-only, without offering a French option (WEBER, 2014). The educational system is frequently described as "multilingual", however given its compartmentalization it can be seen as "step-by-step multilingual" (GÓMEZ FERNÁNDEZ, 2015) since the use of the three official languages is well defined. Thus for instance, Luxembourgish is the main language of instruction from 3 to 6 years of age. Then German becomes the language of instruction beginning in 1st grade (age 6), although Luxembourgish is still quite present in day-to-day interactions. Then in the second semester of the second year of primary studies, age 7/8, children are introduced to French, which will increase its presence until becominga main language for secondary classical studies (Lycée Classique).

Table ii. Languages taught and languages used for instruction (WEBER & HORNER, 2008, p. 89)

[2] http://www.luxembourg.public.lu/en/le-grand-duche-se-presente/population/societe-multiculturelle/index.html

	Main languages taught	Medium of instruction
Pre-school (3 years)		
précoce (age 3/4)	Luxembourgish	Luxembourgish
préscolaire (age 4/6)	Luxembourgish	Luxembourgish
Primary education (6 years)		
(age 6/7)	German as language of literacy, (Luxembourgish: only 1 hour per week)	Luxembourgish, German
(age 7/8)	German, (Luxbg), French added in the 2nd semester	Luxembourgish, German
(age 8/12)	German, French, (Luxbg)	German
Secondaire classique (7 years)		
(age 12/13)	German, French, (Luxbg)	German, French
(age 13/14)	German, French, English (or Latin)	German, French
(age 14/15)	German, French, English	German, French
(age 15/18)	German, French, English	French
(age 18/19)	German, French, English (choice of two of these languages in some streams)	French

In addition to the segmented use of multiple languages, criticism to the educational system has been focused on the early ability tracking, age 12, which has been signalled by the Council of Europe (MENJE & COUNCIL OF EUROPE, 2006) as not optimal. Given that the Luxembourgish system is characterized by a diversity of official languages and a high rate of migration, a later age of selection for secondary studies would perhaps be fairer for all students, but especially for the CLD ones (MENJE & COUNCIL OF EUROPE, 2006). We believe that it is essential for policy makers and teachers to understand that diversity is richness, and if it has its challenges. Educational authorities are aware of the risk factors indicated by the PISA study, a test that takes place when the students are 15 years old. Whether or not the linguistic and cultural richness of CLD students, accounting for almost half of the students, is taken into account, also plays a role in their science and overall school performance.

The main minority in the Luxembourgish school population are Portuguese-speakers, representing an increasing 28 % of the total public school population (MENJE, 2016, p. 16). Many of these students are born and raised in Luxembourg, while growing up in at least two cultures. We refer to these students as Luxemburguês, having Luxembourgish and Portuguese-speaking identities and cultures combined. Unfortunately, PISA results for Luxembourg show that by the time these lusophone students reach secondary school, they are quite behind their Luxembourgish colleagues (OECD, 2013). These students, combined with students from former-Yugoslavia, are 84 points away in science from their colleagues, which equals two

academic years of study (OECD, 2013). The latest PISA results show an improvement for the foreign school population, however Portuguese nationals still remained between 70 and 86 points away from their counterparts (OECD, 2016). In this article, we will show examples of CLD students belonging to these two ethnicities, Portuguese and former-Yugoslavia, as in line with the PISA results these are the two student population most in need of support in science.

THEORETICAL FRAMEWORK

The SciPol:Lux project (Science Education, Innovation and Policy in Modern Luxembourg): An ethnography

Our research projects seek to understand how science topics have been and are taught throughout history in multicultural Luxembourg, considering both local and international education policies. These topics or fields of experience in the curriculum include: i) animal studies, ii) environmental protection, iii) sex education, iv) geology / soil, v) our community develops, and vi) electricity. In the current article we will present samples from three case studies: environmental protection, geology/soil, and our community develops.

To study these three cases, we conducted video ethnography, a qualitative method which allows us to study human behaviour and the meanings behind this behaviour (HAMMERSLEY & ATKINSON, 1983). We spent time in three different schools, one per case. We understand ethnography as Heller does: “In any case, an ethnography will not only always provide some answers, but in the best of cases it will also generate more questions, to be pursued as resources permit” (2008, p. 262). We observed and documented science lessons in three schools when the different classes were teaching and learning some of the topics we were interested in the curriculum.

Building an integrated theoretical framework: “Bricolage”

Our approach is informed by the use of different methodological and analytical ‘tools’. With an influence from sociocultural perspectives (e.g., SEWELL, 1992), our theoretical and methodological background is defined as “bricolage” (LEVI-STRAUSS, 1966). Being a “bricoleur”, or handyman (KINCHELOE, 2001) consists of the use of a myriad of types of tools, and not only merely one tool or approach. According to Kincheloe, bricolage “is concerned not only with multiple methods of inquiry but with diverse theoretical and philosophical notions of the various elements encountered in the research act” (2011, p. 682). Furthermore, Kincheloe defined five types of bricolage: methodological, theoretical, interpretive, political, and narrative. The current study applies bricolage drawing on a myriad of theories and data-gathering techniques.

METHODOLOGY

Methodologically we utilize a critical ethnographic approach (CARSPECKEN, 1996), which allows focus on the power relationships and inequalities between actors in the classroom, so that we can better understand the different roles and changes in identities, and the effect in the learning of science. Further, our theoretical frameworks position identity as constructed, fluid and dynamic (HOLLAND ET AL., 1998). The data collected includes audio-recordings, classroom video-recordings, semi-structured & informal interviews, artefacts (handouts, pictures…) and fieldnotes. Ethnographic methods, in particular, video ethnography, strengthens the reliability (MILES & HUBERMAN, 2014) of the study and we include different types of triangulation (DENZIN, 1970)[3] , including data, investigator, theoretical, and methodological, in order to provide trustworthiness and authenticity (GUBA & LINCOLN 1985).

RESULTS AND DISCUSSION

Culturally and Linguistically Diverse (CLD) students Translanguaging in the science class: Our neighbourhood

In the sections that follow, we present three extracts corresponding to each of the cases we have studied in the SciPol:Lux project. The first one corresponds to a small group of 8 Lusoburguês children of 7 to 9 years-old in an Integrated Language class of science in Portuguese. Through an European Directive from 1977 (77/486/EEC) and under certain conditions, any student has the right to choose to study science in their home language for two hours per week, instead of in the school language. The fact of including the home languages during the school hours legitimates them, a process not always supported. We followed 5 sessions where they were learning about "our neighborhood". Concretely the following example corresponds to a session where students were completing a form for the Town Hall, in order to begin to understand the role of administrative institutions in a community, before visiting this institution in person.

Following is a transcript corresponding to a discussion between the teacher and students regarding the completion of this form. There are two conversations occurring quite simultaneously in the group; on the one hand, the teacher addresses one of the students in Portuguese, and on the other (and in the background or back stage), two students are

[3] **a. Data triangulation**, which entails gathering data through several sampling strategies, so that slices of data at different **times** and social situations, as well as on a variety of **people**, are gathered.
b. Investigator triangulation, which refers to the use of more than one researcher in the field to gather and interpret data.
c. Theoretical triangulation, which refers to the use of more than one theoretical position in interpreting data.
d. Methodological triangulation, which refers to the use of more than one method for gathering data **(interviews, observations, questionnaires, and documents)** (Denzin, 1970)

translanguaging and trying to fill out the form, which is the task assigned by the teacher. The bold letters correspond to the lexical features from Luxembourgish.

Prof: Bom dia o que precisa, qual é a sua vez, numero 6 e o nome, muito bem tem aqui o formulário já sabe preencher, um bocadinho depois vamos explicar melhor	Good morning what you need, what's your turn, number 6 and the name, well here's the form you know how to fill out, a little later we'll explain better
Student1: apelidos (*whisper)*	Surnames (whisper)
Student2: **wei wei?** (*whisper*)	what? what? (whisper)
Prof: a data de nascimento, o sabes o não sabes?	your birthdate, do you know or not?
Student3: 2008	2008
Prof: 2008 só sabes o ano então aqui na linha de baixo vais escrever dois tem de ser tudo com letras dois não não quero com números dois mil é oito, devagarinho vamos escrever tudo com letras. O Catia eu vou chamar terminaste aqui	2008 you only know the year so here in the bottom line you'll write two have to be all with letters two no I do not want with numbers two thousand and eight, slowly let's write everything with letters. Catia, I'm going to call you here.
Student1: **wei schreiwt een zwee**	How do you write a two
Student2: **maat een s**	With an s
Student1: **kann ech net, dois mil e oito**	I can't, two thousand and eight
Prof: Bom dia o que precisa	Good morning, how can I help you?
Student2: **du bass och** dois mil e oito	You are also two thousand and eight
Student1: **ech sinn awer mei aal, awer net mei aal wei Anna meng schwester well hat huet 11** (*whisper*)	But I am older, although not so old as my sister Anna because she is 11 (*whisper*)
Student2: *(not clear)*	*(not clear)*
Student1: **deng schwester,**	Your sister,
Student2: **ass hat meng cousine**	That is my cousin
Student1: **well awer net heeschen Schwester**	Then don't call her sister
Student2: **mee ech well awer**	But I want to do it
Student1: **richteg Schwester**	Sister is right
Student2: **dach. Dass hei** dois mil e sete **maan**	Sure. That here is two thousand and seven
Student: **majo**	yes

Interesting in this interaction is that even in the 2-hrs / week science lesson held in Portuguese, these children's home language, the children make meaning using as much as possible of their linguistic repertoire / idiolect, in spite of the ideologies enacted in the classroom by the teacher. These children are being spoken to by the teacher in Portuguese, while they speak to each other using features from Luxembourgish as well as from Portuguese. There are consequences for the inevitable conflict between step-by-step multilingualism (GÓMEZ FERNÁNDEZ, 2015) and its compartmentalization and the communicative needs of plurilingual students. One of the consequences we could witness during our fieldwork was the punishment of one student for "talking in Luxembourgish". This came as a surprise to us, since

this teacher was previously positioning herself through her discourse as allowing students to communicate in the language of their choice. When the teacher started to reprimand the student, she said: "já fizeste um ano em Portugal, mais não deixas aprender aos outros, falas falas e em luxemburguês e mexes mexes y não paras..." (you've already done a year in Portugal, but you don't let the others learn, you speak and speak in Luxembourgish and you move and move and you don't stop…).

From our theoretical perspectives these lusoburguês students are using their habitual way of communication, which is translanguaging (GARCÍA, 2009). One of the latest definitions of translanguaging defines it as "[…] refers to using one's idiolect, that is, one's linguistic repertoire, without regard for socially and politically defined language labels or boundaries" (OTHEGUY, GARCÍA & REID, 2015, p. 297). These young plurilingual students do not have the, rather artificial, separation that adults often have regarding national or "named" languages. The idea of languages as separate, discrete entities is a social construct (MAKONI & PENNYCOOK, 2007). These children use their full linguistic repertoire when and where possible. Wei (2011) was the first one naming the concept of 'translanguaging space', as she states "I have called the space ''translanguaging space'', a space for the act of translanguaging as well as a space created through translanguaging" (WEI, 2011, p. 1234). García and Kleyn later elaborated: "A more equitable educational space is created through translanguaging, one that is capable of transcending the social reproduction aspects of schooling and generating social transformations that promote social justice" (2016, p. 221). What is at stake here is that these plurilingual students need to create this translanguaging space in a back-stage (GOFFMAN, 1959) since using their idiolect and translanguaging using lexical and syntactical items from their home language is not always allowed by the teacher, at the front-stage. Students have explained to us the dilemma they often face, when they are punished in the regular classroom for translanguaging with Portuguese items in their speech, and similarly in the Portuguese science class when they draw on Luxembourgish items in their speaking.

This is in contradiction to the curricular policy presented in the "plan d'études" as well as in the different recommendations from the Council of Europe (MENJE & COUNCIL OF EUROPE, 2006), where it has been elaborated that home languages not only should be allowed in our schools in Europe, but should be celebrated. This has been reinforced by numerous researchers, and "it is widely believed that inclusion of children's home language in school not only makes instruction comprehensible but also affirms the language and cultural identities children bring from their homes and communities (MACSWAN, 2017, pp. 189-190).

The benefits of translanguaging in the science class have been addressed by several

studies (POZA, 2016; SEMBIANTE, 2016). As Espinosa & Herrera affirm, “translanguaging allows the teacher and the students to mediate complex science learning and language learning” (2016, p. 175); not allowing plurilingual students to translanguage in their science lessons then, “is like telling a carpenter to build a house using only half of the tools at their disposal” (Orellana, 2016, p. 105). Thus, language and science are intertwined, language being yet another resource to explore “the content and processes of science” (WILMES, SIRY, GÓMEZ FERNÁNDEZ, & GORGES, 2018, p. 255). We now turn to a second case study to highlight the ways in which a CLD student engages in science practices when given the space to draw on multiple resources in his repertoire.

A Culturally and Linguistically Diverse (CLD) student “opening up” a task in the science class: Environmental protection

The primary school in this case study is in a small town in the center-west in Luxembourg. The classroom that we observed is a fourth grade class of children approximately eight-years-old. The data collection focused on five sessions taking place from May until July 2016. We initially concentrated on six children whose parents’ consent was granted. The age and nationality of all of them was 8 and Luxembourgish, except for “Pedro”, who was 9 and Portuguese.

Figure iii. Classroom and cameras setup.

This teacher devoted five sessions to the topic of “environmental protection”. We were present in all these sessions, taking field notes and video recording. We would like here to zoom into the fourth session when the students performed an investigation situated by the teacher as an “experiment”. This consisted of a directed task in which the children had to pour dirty water into a three layer water-filter previously made by the teacher. Then they had to fill in a handout naming the three layers of the filter and explaining what happened with the dirty water after being poured in the filter. We have written about this investigation in a previous article (see

GÓMEZ FERNÁNDEZ & SIRY, in production), and in this article we draw on a summary of the findings from that paper to further contextualize what we are learning through our research examining CLD students' participation and engagement in science lessons.

Table iii. Five sessions devoted to "environmental protection", main topics.

Session Number	Main Topic
1	Climate zones, recycling
2	Climate change "experiment"
3	Renewable energies
4	**Water cycle and "experiment"**
5	Review

Along these five sessions we observed the following habitus : i) The teacher explanations usually followed an IRE format (Initiate-Response-Evaluate) in Luxembourgish; ii) the experiments as planned involved limited manipulation; iii) the handouts were in German as the written production and reception was in German (as stipulated by the curriculum); iv) short videos that were often watched were in German; and v) there was often group work with discussion (in Luxembourgish).

We noticed a change of participation in Pedro along the different sessions. His rather modest, quite passive participation changed during the water filter experiment. Before, during and after this group task we noticed and recorded Pedro's change of participation and interpreted it as a change of "footing" (see GÓMEZ FERNÁNDEZ & SIRY, in production). According to Goffman "A change of footing implies a change in the alignment we take up to ourselves and the others present as expressed in the way we manage the production or reception of an utterance" (1981, p. 128). Pedro changed his participation patterns suddenly during the activity with the water filter, even leading the task in his group on several occasions, stating his hypotheses and volunteering in many moments. He was also more willing to manipulate the different objects and showed a "playful" (LYTRA, 2007) attitude. We understand that this playful attitude, far from being off task, helped Pedro lead an "opening of the task" with his peers. For instance, he pretended to be "smelling" or "stirring" the water filter, which we see assisted his peers to open up the task and experiment in different directions with the water filter.

At the end of the five sessions we had a final semi-structured interview with their teacher. During this interview the teacher told us that she realized that the experiments were more interesting for the children than the handouts and videos: "*the experiments are always good because they are always excited to do something, to do something with, they can do themselves...*". Stating also that "*then for the part that worked not so good, I think it was every*

theoretical, where they had to write something down, they are always annoyed by that too, write, much text, so, next time maybe I will do, I will not do too, I will not let them write that much, but more, they should more tell me and discuss and, so, I think next time I will not, do, so much paper work". She further stated that she would not give so many hand outs in the future "*I would not give them that many worksheets*".

We also asked her about Pedro, since he is a CLD student and given that his change in participation was rather significant when working within a more practice-based science approach. The teacher explained that some of her students "need more experiments and manipulation to be motivated". The teacher realized that CLD students like Pedro can have the same participating and learning opportunities in science when a hands-on and participative approach is in place. In writing about secondary school students, Rodríguez (2015) has written about how teacher-centered, content-heavy lessons in science can lead to disengagement of CLD students: "A growing research base shows that this approach aggravates students' disengagement with science— especially for culturally diverse and ELLs who often view science as a monolithic and disconnected to their lives" (p. 452). Our work underscores the necessity to push back at transmissive, teacher-driven lessons in order to create spaces for CLD students to become more engaged in science, as Pedro did when he had the time and opportunity to participate in a science investigation in ways that were conducive for his meaning-making.

Culturally and Linguistically Diverse (CLD) students documenting in a safe science notebook in the science class: Geology / soil

In this third case study, we examine the use of science notebooks in a primary school located in a small town in the center in Luxembourg. The classroom we observed is a Kindergarten class, with children averaging 5-years-old. The data collection focused on five sessions taking place from February until July 2016.

Figure iv. Main classroom space for whole group discussions. Three cameras were covering the different angles.

This particular class had a daily routine which valued and celebrated linguistic and cultural diversity in the classroom. They started the day singing "good morning" in different languages represented in the classroom, with the children being the ones choosing the language, starting with the language chosen (good morning, good morning) and then the rest of the song in Luxembourgish. Here an example starting in Portuguese and continued in Luxembourgish: “Bom dia, bom dia, sangen all eis Kanner, Déi ganz grouss, déi ganz kléng, hëllefen net manner” (Good morning, good morning, sing all the children, the big ones, the small ones, help no less).

Table iv. Main activities taking place during the five sessions

Session N.	Main Topic
1	Presentation of the worms, box, science journals
2	**Group observation, group water & light experimentation, notebook documentation**
3	**Individual experimentation + documentation, film**
4	Group observation, soil, documentation, outdoors excursion
5	Final activity (wind mills)

There are two teachers in this data set, the classroom teacher alias ‘Sabine’, and a supporting science teacher, alias ‘Jean’. Sabine is a primary school teacher with an extensive experience and positive recognition in her school. Jean is a primary school teacher and also a lecturer and researcher at the university, and he provides insights for this classroom and the school as a whole. The lessons we documented were a part of a unit on worms, and neither of the teachers had used worms before in the soil unit and thus they asked for assistance and collaboration from our research team. These teachers adopt an inclusive approach in their teaching, and they work with the children to discover about the subject at hand. For instance, the teachers never announced to the children that they had worms with them but instead they tried to raise the interest among the children by exploring and learning together. The children and the teachers inquired together and then showed each other their discoveries, following Freire (1970/2003):

> The teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in turn while being taught also teach. They become jointly responsible for a process in which all grow. In this process, arguments based on "authority" are no longer valid; in order to function, authority must be on the side of freedom, not against it. Here, no one teaches another, nor is anyone self-taught. People teach each other, mediated by the world, by the cognizable objects which in banking education are "owned" by the teacher. (p. 80)

By aiming at inquiring together, the teachers also reduce their own authority and give

some control and power to the students. They explained to the children that it was their first time they were using worms in the classroom, thus positioning themselves as novices in the topic, something not usual in the teaching community. Siry (2012) believes that if science is approached as a communal practice, teachers do not necessarily need to be experts to be able to teach it: "…we instead embrace notions of science as a communal practice—one that is lived and generated in the practices—teachers do not need to be necessarily ''experts'' in a content area such as science" (p. 302).

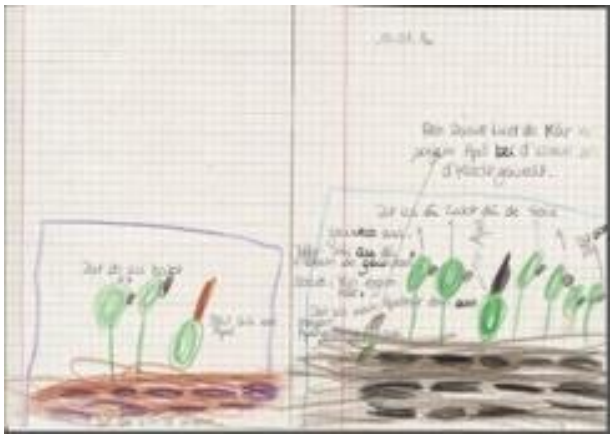
In this group we found surprising the change in participation of "David". David is a CLD student with ex-Yugoslavian family background. This ethnolinguistic group has a high risk of school failure, together with the Portuguese-speaking students (MENJE, 2016). From the beginning and during the first two sessions David showed a predisposition for participation in the worms activities, however he appeared to be too scared to touch them or even to be close to them. During the second and third sessions, where the children could investigate at three work stations, they could openly do research on the worms in an inquiry-based approach. For that purpose they could use their science notebooks and then document their discoveries.

Figure v. David's development with regard to his behaviour towards the worms and his identity in his class.

Student science notebooks have proven to be very positive for the teaching and learning of science. Among others, Klentschy states "student science notebooks have also proven to be

the best record of what science content is actually taught by teachers in classrooms and learned by students and provide an excellent ongoing assessment and feedback tool for teachers" (2008, p. 1). Based on the data analysed in this case, we understand that science notebooks, introduced in the first session, can be positioned as "safe spaces". As Holley & Steiner state "The metaphor of the classroom as a 'safe space' has emerged as a description of a classroom climate that allows students to feel secure enough to take risks, honestly express their views, and share and explore their knowledge, attitudes, and behaviors. Safety in this sense does not refer to physical safety. Instead, classroom safe space refers to protection from psychological or emotional harm" (2005, p. 50). While Holley & Steiner are referring the overall classroom as a safe space, Marcarelli has referred to the use of notebooks as a safe space, although in that study the focus was on writing: "When working with English language learners or students with special needs, the interactive notebook is an effective tool for the development and reinforcement of scientific or academic language. The notebook provides a safe place to practice writing and express prior knowledge and newly acquired knowledge" (2010, p. 4). In our current study the children had not learned to write yet, yet the notebook was highly appreciated by the children as they could draw their discoveries and share them with the teacher, who would then do the writing. As Fulton (2017) states: "…notebooks can provide students with an insightful way to think about and do science like scientists" (p. 85). Furthermore, this oral-written practice seemed to stimulate and motivate the children even more towards literacy.

Figure vi. Last page of David's science notebook.



FINAL CONSIDERATIONS

All along the three cases presented in this article we have witness how important ***space*** is for CLD students. They need the space for translanguaging, for "playing" and opening up tasks, for taking leading roles, and for exploring and drawing their discoveries in notebooks. These all became safe places to can inquire, places where there is open exploration, where they

have freedom to write down and think, about science. This semi-free spaces are, for the CLD students, the space they deserve, and we posit that it is critical to also include their languages and cultures in the science class while we provide these space to them.

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