

Teacher-Designed Materials Focused on Problem-based Learning to Develop Inquiry Skills

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PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

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PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Abstract

This qualitative action research study, analyzed the contribution of teacher-designed materials in the development of students' inquiry skills. For this study the skills selected were Observation, Prediction, Interpretation and Communication (OPIC). The study took place in a private school in Bogotá with a sample of ten second graders, in the Science class. Six worksheets were designed based on the Second Language Acquisition principles (SLA) focused on problem based learning approach. The data gathering instruments used during the intervention were; students' artifacts with their corresponding self-assessment, field notes and focus group interview. Data was analyzed by using the grounded theory and the color coding technique. The findings showed that teacher-designed materials promoted self-construction of knowledge, understanding the socio-cultural context using sequenced worksheets that favored students' preferences and provided strategies to achieve communicative goals and independent practice supported by feedback. Moreover, problem-based learning strategies benefited the identification and description of elements and situations to find needs; comparison led to suitable outcomes on problems; and inquiry skills were enhanced through observation and prior knowledge for accurate prediction and appropriate interpretation of data that supported different ways of communicating results.

Key words: materials development (MD), problem-based learning, inquiry skills

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Resumen

Esta investigación- acción cualitativa, analizó la contribución de los materiales diseñados por docentes en el desarrollo de las habilidades de indagación, Observación, Predicción, Interpretación y Comunicación (OPIC). El estudio se realizó en un colegio privado de Bogotá con una muestra de diez estudiantes de grado segundo en clase de ciencias naturales. Se diseñaron seis guías de trabajo en clase, fundamentadas en los principios de adquisición de la segunda lengua y el enfoque de aprendizaje por problemas. Los instrumentos de recolección de datos utilizados durante la intervención fueron los artefactos de los estudiantes con sus respectivas autoevaluaciones, notas de campo y entrevista al grupo focal. Los datos se analizaron a partir de la teoría fundamentada y la técnica de codificación de color. Los hallazgos mostraron que los materiales diseñados por la profesora promovieron la autoconstrucción del conocimiento, entendiendo el contexto sociocultural y utilizando guías de trabajo en clase que favorecieron las preferencias de los estudiantes y proporcionaron estrategias para lograr objetivos comunicativos y una práctica independiente respaldada por la realimentación. Además, las estrategias de aprendizaje para la solución de problemas beneficiaron la identificación y la descripción de elementos, y situaciones para encontrar necesidades; la comparación condujo a resultados apropiados en la solución de problemas; y las habilidades de indagación se mejoraron a través de la observación y el conocimiento previo, para la predicción precisa y la interpretación adecuada de los datos, que admiten diferentes formas de comunicar los resultados.

Palabras clave: desarrollo de materiales, aprendizaje por problemas, habilidades de indagación

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

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Description

This action research study aimed at identifying the impact of the teacher design materials focused on Problem-based learning approach in the development on the inquiry skills (observation, prediction, interpretation and communication) in second graders at a private school in Bogotá. The data gathering instruments selected for this study were: students' artifacts, teacher's field notes and focus group interviews. The participants of this research study were 10 students from second grade selected under the convenience sampling technique, the teacher as researcher and materials designer.

The literature review was divided in three constructs: Materials Development, Problem-based learning and Inquiry skills. For Materials development, the construct was covered from the definition of materials, materials as a field of study and materials typology based on scholars such as Gomez (2010, 2015), Montijano (2014), Núñez and Téllez (2015,2009), Núñez et al. (2013), Tomlinson (1998, 2003, 2010, 2011), Rico (2005). For Problem-based learning I introduced PBL as a pedagogical approach, its historical framework and the teacher and students' role based on Boud and Feletti (1997), Othman and Ahamad (2013), Stepien and Gallagher (2001). For Inquiry skills, it was described the focus on guided inquiry, the principles of guided inquiry and teaching science through inquiry skills, based on references such as Kuhlthau, Maniotes and Caspari (2007), Peters, and Gega (2005), Science Scheme of Work Stage three (2015).

The findings after the triangulation and analysis of the instruments showed that the worksheets sequenced the learning activities gradually so they could learn in a relaxed way, the way in which students could develop the worksheet respected learning styles and since there was plenty of opportunity of interaction, students could attain practicality and particularity. Students benefited from PBL strategies to identify and solve problems, the inquiry skills were enhanced when observation lead to accurate predictions, and the appropriate interpretation of data was supported by different ways of communicating results.

References

- Ash, D. (1999). The process skills of inquiry. In *Foundations A monograph for professionals in science, mathematics, and technology education. 2*, (pp 51-62).
- Bitsch, V. (2015). Qualitative research: A grounded theory example and evaluation criteria. In *Journal of Agribusiness. Agricultural Economics Association of Georgia*, p.10
- Boud, D., & Feletti, G. (1997). *The challenge of problem-based learning*. London:Kogan

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Burns, A. (1999). *Collaborative action research for English language teachers*. Edinburgh: Cambridge University Press.
- Cresswell, J. (2012). *Qualitative inquiry and research design*. Thousand Oaks, CA: Sage.
- Denzin, N. (1989). *Interpretive interactionism*. Newbury Park, CA: Sage
- Gómez, L. F. (2010). English textbooks for teaching and learning English as a foreign language: Do they really help to develop communicative competence? *Educación y Educadores*. 13(3), 327-346.
- Gomez, L. F. (2015). En The cultural content in EFL textbooks and wath teachers need to do about it. *PROFILE Issues in teachers "Professional Development*, 17(2)167-187). Retrieved from: <http://dx.doi.org/10.15446/profile.v17n2.44272>
- Kuhlthau, C., Maniotes, L., & Caspari, A. (2007). *Guided inquiry, learning in the 21st century*. London: Libraries unlimited.
- Kumaravadivelu, B. (2003). *Beyond methods: macro strategies for language teaching*. New Haven; USA: Yale University Press.
- Markee, N. (2001). *The diffusion of innovation in language teaching*. London: In Hall, R & Hewings.
- Marshall, S. (1995). *Schemas in Problem Solving*. Cambridge University Press.
- Montijano, M. (2014) Textbook use training in EFL teacher education. *Utrecht Studies in Language & Communication*, 27, 267-285)
- Núñez, A., Pineda, C., Téllez, M. (2004). Key aspects for developing your instructional materials. *PROFILE Issues in Teachers' Professional Development*, 5, 128-139. Bogotá: Universidad Nacional de Colombia.
- Núñez, A., & Téllez, M. F. (2009). ELT materials: the key to fostering effective teaching and learning settings. *PROFILE: Issues in Teachers' Professional Development*, 11(2), 171-186.
- Núñez, A., & Téllez, M. F. (2015). Reflection on teachers' personal and professional growth through a materials development seminar. *HOW, A Colombian Journal for Teachers of English*, 22(2), 57-74.
- Núñez, A., Téllez, M. F., & Castellanos, J. (2012). A framework for materials development: A path for in-service teachers to build up the instructional design of their research studies. In Núñez, A., Téllez, M. F. & J. Castellanos (Eds.), *Teacher research on English didactics issues* (pp. 17-37). Bogotá: Departamento de Publicaciones Universidad Externado de Colombia.
- Núñez, A., Téllez, M. F., & Castellanos, J. (2013). Document: Proposal for the research line materials development and didactics (Ascribed to the Research Group: Critical Pedagogy and Didactics for Social Transformation). Universidad Externado de Colombia.
- Núñez A., Téllez M., Castellanos J. and Ramos B. (2009). *A practical material development guide for EFL pre-service, novice, and in-service teachers*. Bogotá: Departamento de Publicaciones Universidad Externado de Colombia.
- Othman, N. & Ahamad, M. (2013). Problem-Based Learning in the English Language Classroom. In *English Language Teaching*; Vol. 6, No. 3. Canadian Center of Science and Education.
- Peters, J., & Gega, P. (2005). Developing inquiry skills. En *Science in elememtry eductaion* (págs. 80-108). New Jersey: Prentice Hall.
- Potter, J. (1996) *An Analysis of Thinking and Research about Qualitative Methods*. Psychology Press Publishers. California
- Rico, C. (2005). The Matter of Selecting and Evaluating Materials. *MATSDA Folios*.
- Schmidt, H. (2012). *One –day, one-problem. An approach to problem-based Learning*. Springer Ed: Singapore
- Science Scheme of Work, Stage three. (2015) London: Cambridge University Press.
- Stepien, W., & Gallagher, S. (2001). Problem-based learning: As authentic as it gets. *Educational Leadership*, 50.
- Stevens, J. 1996. *Applied multivariate statistics for the social sciences*. 3rd ed. Mahwah, NJ: Lawrence Erlbaum Associates.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Stottok, B., Bergaus, M. & Gorra, A. (2011). *Color coding: an alternative to analyze. Empirical data via grounded theory. Research Methods*. Retrieved from <http://connection.ebscohost.com/c/articles/62796110/colour-coding-alternative-analyze-empirical-data-via-grounded-theory>
- Tomlinson, B. (1998). *Materials development in language teaching*. London: Cambridge University Press.
- Tomlinson, B. (2003). *Developing materials for language teaching*. London: Cambridge University Press.
- Tomlinson, B., (1999). *Materials development in language teaching*. United Kingdom: Cambridge U Press. (Original work publisher 1998).
- Tomlinson, B. (2011). *Materials development in language teaching*. London: Cambridge University Press.
- Tomlinson, B. & Masuhara, H. (2010). *Research on materials development for language learning. (Eds.) Research for materials development in language learning, evidence for best practice. (2-18)*. New York: Continuum International Publishing Group.
- Tudor, I. (2001). *The Dynamics of the language classroom*. Cambridge University Press.

Content

This research study comprises five chapters. The first one deals with the statement of the problem, research question, general and specific objectives as well as the related studies of the theoretical construct. The second chapter addresses the literature review which supports the three main constructs of this research. The third chapter reports the research and instructional designs. The fourth one describes the findings and the theoretical support. The fifth chapter addresses the conclusions, pedagogical implications, limitations and questions for further research.

Methodology

The research design for this qualitative study included the description of the type of study, in this case action research, according to the model of Burns (2011), it was necessary to select an issue from the teaching or the learning process, observe the matter and pose a question to design a plan, finally, organize the data gathered and improve the practice. The participants were selected using the convenience sampling technique proposed by Marshall (1996), Potter (1996) and Stevens (1999). The data reduction was done using the color coding technique (Stottok, Beragaus & Gorra 2011; Creswell 2012); and it was validated through the data and methodological triangulation (Denzin 1989; Bitsch 2005).

For the instructional design, the pedagogical intervention included the design of six contextualized worksheets with their corresponding self- assessment which were divided in three main stages, exploration stage, guided inquiry and independent inquiry. The worksheets were designed considering Second Language Acquisition principles and had determined objectives. The intervention as an innovation presented this study as it was innovative for students since the worksheets were designed for their specific group, innovative as well for the research line in the theoretical and methodological aspects and for the teacher in the exercise of creating materials enlightened by theoretical frameworks and principles (Markee 2001; Núñez, Tellez & Castellanos 2012). From the theory of nature of language, the study was functional and promoted the self- expression, and from the from the language learning it was experiential and analytical (Tudor 2001).

The methodological approach was centered in the Problem-based learning solving situations following logical guidelines through the stages of inquiry skills. To fulfill the objectives and after analyzing the contributions of different scholars, this research study proposed a pedagogical intervention that started with a diagnostic survey to set objectives, a sensitization stage to engage and motivate students, the creation and piloting of materials, appraising the materials, and finally improving the worksheets for their implementation.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Conclusions

Implementation of teacher designed materials promoted self-construction of knowledge helping students to go from theory to the practice by finding what was being learnt useful and relevant (Kumaravadivelu, 2003). Understanding the socio-cultural context, allowed students to be an active part of their learning process and to feel empowered about their improvement and needs.

Materials that were sequenced provided students with strategies to achieve communicative goals and independent practice had a highly positive impact in students' self-investment (Núñez et al., 2004; Núñez & Téllez, 2009; Shaw and Masuhara, 2012; Tomlinson, 2011)

PBL permitted identification and description of needs, promoted opportunities for interaction and learning by experiencing, and a deeper understanding of reality and self-discovery of their own abilities (Boud & Feletti, 1997; Schmidt, 2012).

Teacher constant monitoring encouraged students to go through observation and prior knowledge for accurate prediction and appropriate interpretation of data that supported different ways of communicating results (Kuhlthau, Maniotes & Caspari, 2007). Students proved to be able to overcome the situations by preventing them based on their observations and predictions, and that way being ready to solve problems based on what they already knew and being able to look for what they needed to know (Ash, 1999).

There were three main pedagogical implications, first for students considering the positive impact the materials had on them. Students were engaged and motivated, committed to the development of the worksheets, and to their science orchard project. The second impact was on the school where the study was carried out since the materials and the orchard project showed excellent results and the environmental sciences department considered the needs of creating materials that could be more adequate for the synthesis project that students have to present at the end of every school year. Finally, the implications on the teacher as researcher and designer and the professional development that implies changing the way in which all the classes and materials were thought and the needs of theoretical background and principles to guide the professional practice.

Finally, the questions for further research are centered on the design of materials focused on Problem-based learning in subjects such as mathematics and language arts and their impact in the comprehension and development of thinking skills.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Table of Contents

Acknowledgments.....	iii
Abstract.....	iv
Resumen Analítico En Educación - RAE	vi
Introduction.....	1
Chapter I.....	3
Statement of the Problem.....	3
Research Question.....	4
Research Objectives.....	4
General objective	4
Specific objectives	4
Related Studies.....	4
Setting and Rationale	7
Setting	7
Rationale	8
Chapter II	10
Materials Development.....	10
Materials development as a field of study	10
Definition of materials	11
Materials development aspects	11
Typology of materials	13
Problem-based learning.....	16
Problem-based learning as a pedagogical approach	16
Historical framework	17
Teachers and students' role in Problem-based learning	18
Inquiry Skills.....	19
Focus on guided inquiry	19
Principles of guided inquiry. T	20
Teaching science through inquiry skills	21
Chapter III.....	24
Research Design.....	24
Research approach	24
Type of study	25
Participants	26
Data gathering instruments	27
Instructional Design.....	29
Pedagogical intervention	29
General and specific objectives	33
Intervention as an innovation	33
Theory of the nature of language and language learning	34
Methodological approach	35
Connection of the pedagogical intervention with the research question	35
Instructional phases	36
Sample worksheet.....	40
Chapter IV.....	50
Data Analysis Procedure.....	50
Research Categories and Subcategories.....	52

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter V	84
Pedagogical Implications	86
Limitations	88
Questions for Further Research.....	88
References	89
Appendix A	99
Appendix B	102
Appendix C	104
Appendix D.....	106

List of Diagrams

Diagram 1. Action Research Cycle (Burns, 2001)	25
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List of Tables

Table 1. Worksheets Chronogram	38
Table 2. Categories and Sub-categories for the Research Question.....	53

Introduction

The present qualitative action research explores the development and implementation of Problem-Based Learning materials for second grade elementary students, and analyses the way it allows them to improve their inquiry skills in a meaningful, challenging and engaging way. The study took place within a science class using English as the only language of interaction. Therefore, it was important to consider the current legislation for education in Colombia and the national standards not only for English language but also for science teaching.

The Colombia Ministry of Education (MEN hereafter for its acronym in Spanish) suggests that it is necessary to invest time and effort in an integrated syllabus where students find the opportunity to use the new language, to read and write in other subjects such as science, (MEN, 2002 p. 14). On this respect, the Colombian Framework for science teaching is not separated from the National English Program “Colombia Very Well 2015-2025” and its main purpose which is to include the development of an English curriculum that allows competent and fluent speakers (MEN, 2014). Thus, this study integrated both the use of language and the necessary skills for the science program with the target population.

I developed this study in response to my professional concern on students’ awareness of their ability to use their inquiry skills to show and share their understanding of different topics using the English language. I noticed students already regarded English to learning content subject matters taught in English. However, they did not find what they learn useful; therefore, they were not engaged and motivated.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

It is worth to mention, students had access to different sorts of materials such as Science textbooks. However, those textbooks were not designed for them, and they were selected bearing in mind economic reasons and international programs, and although they covered a wide range of the topics students are supposed to have in the syllabus they did not represent significant learning for students. As mentioned by Kumaravadivelu (2014), “Teachers in other countries and other cultures have been assured that this one is the correct one, and that their role is to adapt it to their learners, or their learners to it” (p. 73). In the case of the second graders the books did not fulfill the needs in terms of the orchard project; thus, I realized they needed resources or didactic materials that suit their language learning, academic and affective needs. In this case there were not textbooks that could be assertive in such specific project and its implications in terms of methodology and development of skills.

This research document has been organized into five chapters. The first one refers to the statement of the problem, the research question as well as the general and specific objectives and related studies of the theoretical construct. The second chapter refers to the literature review that supports the constructs of this research. The third one describes the research and instructional designs. The fourth chapter presents the findings and supports them with the theoretical insights. The fifth chapter presents the conclusions, pedagogical implications, limitations and questions for further research.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter I

Research Problem

Statement of the Problem

Looking for activities to implement in my classes, I have had the opportunity to use different sorts of materials such as textbooks, internet worksheets, virtual labs and some other class workshops, which I have designed based on the needs of the students but mostly in favor of the program itself. The textbooks generally selected by the school are focused on the standards and objectives of the Cambridge program and teachers are not involved in the selection of such materials.

I began by analyzing my own class observations kept in a reflective journal, carrying out three loop writing activities, designing and conducting a survey (See Appendix A) and looking at the assignments and assessments in which my students got better results not only in terms of grades but especially in terms of understanding. I identified a pattern; my students learned better when they found it worth it, and so it happened when I tried to give them mysteries, problems to solve or proposed a question to guide the development of the class; in contrast, if what they were learning was not meaningful or significant, they started having more difficulties in associating concepts, communicating findings, making predictions, and in general making accurate use of their inquiry skills.

It was clear for me that no matter the amount of materials they could access, it would not satisfy the development of inquiry skills. As Gray (2010), stated “an important conclusion coming from content analyses of ELT textbooks is that regardless of its socio-politically relevant issues are included, activities favouring the development of critical thinking tend to be omitted” (p. 91). Due to those findings, I proposed teacher-designed

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

worksheets to overcome these needs and to relate the materials to their real context and needs.

Research Question

What does the implementation of teacher-designed materials focused on a Problem-Based Learning (PBL) approach reveal about inquiry skills in second graders at a private school?

Research Objectives

General objective. To implement teacher-designed materials focused on a Problem-based learning approach to improve inquiry skills in second graders at a private school.

Specific objectives. (a) To explore the appropriateness and usefulness of PBL materials in enhancing primary student's inquiry skills; (b) to analyze the way students solve a real context situation through a reflexive sequence; (c) to describe the process in which students make accurate interpretations and communicate their findings about an observed event.

Related Studies

According to the problem stated above, it is relevant to consult what other researchers have done, identify findings in similar contexts, and the way they can contribute to this research. After a deep search on the different national indexed journals and data bases such as Jstor, Ebsco, Eric, Redalyc, Fuente Académica Premier, Communication & Mass Media Complete y Academic Search Premiere), Science Direct, Sage Premier, Cengage, Scielo, Biblat y Dialnet; and free access one like Directory of Open Access Journals y Open Access Thesis and Dissertations, I did not find researches

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

that matched the constructs of my research in the same setting (private school, second grade); consequently, I selected the following related studies because of their relation with the constructs of this study even when their contexts are slightly different.

Regarding materials development and PBL, the case study conducted by Hidalgo Davila and Caicedo Vela (2011) in an elementary school in Pasto, Colombia, was conducted with a small sample of 15 students ranged from 8 to 10 years old, by the teachers of Universidad de Pasto, who considered, Content-based instruction materials could help improve the language skills in their students. They designed four units for the content area subjects in which they covered the topics from a problem-based learning approach. This way they concluded, when students had a problem to solve and they could relate it to their real life they learnt in a very effective way. According to that experience the use of strategies focused on PBL in Content- based classes are effective and students at this age can perform much better than just in the teaching of contents in a traditional way.

Similarly, PBL has kept on being implemented in the materials design in other countries. Yu, (2015) carried out a qualitative action research in the languages department of the Med School of Suranaree University Thailand. She re-built the syllabus focusing on students' real needs, creating and adapting the language teaching materials so students could solve problems following sequenced tasks. The instruments included journals, teacher's field notes and students' artifacts. She concluded that the complicated process of materials design required collective knowledge and experience in mastering the topics, it also concluded that students were encouraged and motivated, and it was beneficial not only for the language acquisition but also to the Med school itself. This study is relevant to mine since both focus on students' needs and trust in the mastery of the program of the teacher designer.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

In relation to PBL and inquiry skills, Parada (2008), conducted a qualitative case study related to learning English through inquiry, among a group of sixth graders, in three public schools in Boyacá Colombia. The instruments used for data collection included; reflective journals, semi-structured interviews and students' artifacts. After implementing the cycle method, the researcher concluded students positively applied the skills developed in the English Language to their personal and social fields. The relevance of this study relies on the development of inquiry skills that helped students to establish a relation between what they know and how it contributes to their close environment, and therefore, the impact is not only in academic terms but in their immediate context.

Also, the action research study carried out by Mendieta (2009) at a private girls' school in which by making inquiries in the language class, students used literature as an excuse to approach social problematics teenagers face around the world. The instruments used were students' artifacts, field notes and videotaped sessions. The research concluded that students could propose possible solutions to the problems they found after following the inquiry process. This study is pertinent to mine in relation to the way students, interacting with their real-life problems, can use their inquiry skills as a tool for solving problematic situations. It also shows how once certain skills are developed they can be extrapolated and applied to other contexts.

Following the inquiry skills and materials design, Sandoval (2015) conducted a qualitative - quantitative case study in the primary level of a public school in Bogotá Colombia. She observed and evaluated the impact on the inquiry skills when designing lessons, based on the program "Pequeños científicos" promoted by The Andes University, and adapting the modules designed by the teachers for their immediate context. With a sample of 55 students and using as instruments questionnaires, open interviews and

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

documental analysis, she concluded students showed greater interest in topics they found relevant for their contexts as well as an improvement on the way to approach problems and solve science questions. This study shows the efficacy of teacher- designed materials in the development of inquiry skills when they are contextualized.

Likewise, Herrera and González (2015) carried out a mixed method study at Universidad Veracruzana, in which 12 undergraduate students from an online English program were exposed to the Community of Inquiry Program to foster oral skills. Teachers as facilitators designed meaningful scenarios in which students could trig, explore and solve situations. They used as instruments semi-structured interviews, online surveys and oral tests. They found the nature of the program itself was a limitation due to the very few changes that were accepted, but students perceived as meaningful and more appealing the adaptations teachers made. Considering the role of the teacher as a facilitator who designs meaningful materials for students, it demonstrates the effectiveness of the role of the teacher as a designer for this research study.

Setting and Rationale

Setting. This Study took place at a private school located in Guaymaral a small municipality close to Bogotá, Colombia. This school is part of the International Cambridge Bilingual Schools and as such, it develops the science, math and language programs according to the Cambridge objectives, as well as accomplishing the policies and regulations of the MEN.

According to the School's Educational Study (PEI), the Gimnasio Colombo Británico school offers an international bilingual education program aimed to promote leadership and social sensitivity by teaching values, as well as a high level of proficiency in all the curriculum areas and to encourage students to be technologically aware, so they can

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

succeed and transform the world (Manual de convivencia, mission and philosophy, 2016).

The target population corresponds to second grade students, science class. Students are between eight and nine years old. In average, the number of students per class is twenty-six with an equal number of boys and girls in each class. For the Cambridge program, the science scheme of work focuses its objectives in the use of a scientific enquiry approach along with the topics and units planned for the academic year. It provides each grade level with a list of objectives that needs to be accomplished by the end of the school year (Cambridge Scheme of Work – Science stage 3, 2015).

Rationale. As a language teacher, I have always been interested in helping my students develop mental processes which helped them communicate their ideas in an effective way rather than focusing only on the English language skills. Noticing my students had a very good level of proficiency in the target language, allowed me to identify other processes that required improvement, in this case their inquiry skills. Once students overcame their difficulties in these mental processes, they could use English in a more effective way to communicate their ideas, hypothesis and results fluently and accurately.

This study allowed students to solve problems they found in their immediate context using processes and methods based on their inquiry skills. Since the process of solving problems implies the design and implementation of plans, using observations, making predictions, interpreting results and communicating findings. This in turn, might help the improve in all subject areas, not only English and science.

This study is relevant for the school context since our students were getting used to study only for getting good results in exams or international tests, which took them to memorize vocabulary they used to explain topics of an explicit unit, but they could not make connections among them; in fact, this situation was affecting their performance.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Being prepared to face challenges, adapting and implementing their inquiry skills to the resolution of different situations was a plus in their school life and in their comprehension of different areas. This research study attempted to help students to develop the skills they need to be problem solvers and therefore, empowering their leadership as world citizens which will eventually have to work in teams.

Moreover, this study was relevant because of the contribution to their immediate family and community context in the search for solutions to school and domestic situations that they identified as problems to be solved. Finally, this research study also contributed to the Research Line on Materials Development and Didactics ascribed to the Research Group: Critical Pedagogy and Didactics for Social Transformation since not many studies about these kinds of materials based on PBL to develop inquiry skills have been developed in Colombia. Being part of this line of study encouraged to respond to the ideals of the research line which are “justice, equity and inclusion” (p. 6); “empowerment and autonomy” (p. 7); and “quality assurance and professional development” (p. 8) through the design of materials that focused on students’ needs and contextual realities provide opportunities to grow in each of the ideals, guiding students to become productive leaders able to find suitable outcomes to several situations. (Núñez, Téllez & Castellanos, 2013). This research study is aligned with the ideal of empowerment and autonomy through the improvement of inquiry skills and leadership that students use in different contexts in the second language.

Once the problem, objectives and generalities of the study have been stated, on the next chapter I am going to develop the theoretical constructs which support this research study.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter II

Literature Review

As I mentioned in chapter one, the purpose of this research is to develop and implement materials on the Problem-based Learning approach to improve students' inquiry skills. Therefore, the theoretical constructs for this research are materials development (MD), Problem-based learning and inquiry skills. In this chapter, I included scholars such as Gilmore (2007), Gómez (2010, 2015), Núñez and Téllez (2015; 2009), Núñez et al. (2013), Montijano (2014), Rico (2005) and Tomlinson (1998, 2003, 2010, 2011) for materials development; Bloud and Felletti (1997), and Stepien and Gallagher (2001) for Problem-based learning; and Kuhlthau, Maniotes and Caspari (2007), Peters and Gega (2005) for inquiry skills; and approaches that better define and develop the constructs that inform academic background that supported this research.

Materials Development

Considering Materials Development (MD henceforth) as the main theoretical construct of this research, it is essential to review influential work that has been written about it. As teachers, we adopt materials to achieve the class objectives according to our needs, but usually the materials do not correspond to our context or our students' needs and likes. Such situation represents the biggest challenge when teaching in an EFL classroom; therefore, it is necessary to know the theory and principles behind this field of study and to avoid designing only by instinct.

Materials development as a field of study. To begin developing this construct, it is a must to consider some definitions from the scholars. According to Tomlinson (2011), MD “as a practical activity it involves the production, evaluation and adaptation of materials. As a field it investigates the principles and procedures of the design, writing, implementation,

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

evaluation and analysis of materials” (p. 144). In the same matter, Núñez et al. (2013) stated that “as a field of study, demands an informed methodology that allows validating the efficiency, appropriateness and relevance of materials within the context of learning a language” (p. 10). For Graves (2000) MD “ is the planning process by which a teacher creates units and lessons within those units to carry out the objectives of the course” (p. 149). They agree on the importance of recognizing the procedures and methodologies that permit to affirm that MD is not only a practical exercise to achieve an objective in class but necessarily a field of study.

Definition of materials. Language teaching materials are a valuable resource for both teachers and students. To define materials, Tomlinson (2011) stated that “the term is used to refer to anything which is used by teachers or learners to facilitate the learning of language” (p. 2). This definition offers a wide vision of the materials we use and goes beyond the creation of workshops or use of textbooks that teachers commonly adapt.

In our education system, it is very common to find textbooks as mandatory materials, however, Rico (2005) invited teachers to evaluate the relevance of such texts since “there is not any ideal textbook to teach English, therefore the teacher should adapt the material to suit the particular learning situations” (p. 1.) On the same matter, Núñez et al. (2013), claimed that “materials in the field of language teaching/learning are socio-cultural resources that facilitate not only linguistic interaction but also cultural exchanges between the various human groups” (p. 10). Based on this, it is necessary to conceive materials as a serious responsibility since they must respond not only to the syllabus but also to students’ needs and their context.

Materials development aspects. Teachers are the direct materials developers; they are the ones in charge of finding the meeting point between the programs we must teach

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

and our students' needs, which is not always found in the textbooks or Internet workshops. We can therefore affirm that teachers "are ultimately responsible for the materials that their learners use" (Tomlinson, 2003, p. 3). This responsibility involves more than the materials or the topics; it implies a complete planning and preparation from the developer, designing materials must have a pedagogical goal; therefore, "it should not turn into a meaningless task with the sole purpose of enjoying and keeping the students busy" (Núñez & Téllez, 2009, p. 173). The responsibility we have as developers involves our students, our teaching programs and our personal and professional development.

When teachers turn into materials developers, they must consider several factors. As Núñez and Téllez (2009) found, "Teachers should do their best to develop the most effective, appropriate, and flexible materials... it requires designers to be reflective, resourceful and receptive agents about their teaching practice" (p. 5). Among the components of designing materials, its effectiveness depends not only on how appealing they are for students, but also on how they cover their needs and if they find them significant and useful. As a matter of fact, a teacher who prepares himself as a developer needs to know the target population and, therefore, be ready to construct and deconstruct the materials; be flexible, innovate, redesign or update materials.

Materials should be planned and designed for students' specific needs. As mentioned by Núñez and Téllez (2009), it is necessary to encourage teachers to design materials adapted to our students needs instead of making them work with contexts they find unknown and meaningless to them. The authors further state:

As we can see, carrying out a needs assessment goes beyond recognizing students' deficiencies. It implies making informed academic decisions that will, in turn, enable teachers to envision alternative learning routes to meet different needs, teaching

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

environments, and students' profiles. In other words, implementing the needs assessment process will allow for more meaningful, dynamic, challenging, enjoyable, and effective learning settings (Núñez & Téllez, 2009, p. 175). Thus, materials design is more than a creative exercise; it implies a deep knowledge of the purpose and objectives pursued, and an accurate implementation of approaches and theoretical frameworks that have been proved to be successful.

Typology of materials. To be able to develop materials, it is important as teacher researchers to be aware of the types of materials we have used or can use for our purposes. Traditionally, EFL teachers have used textbooks provided and selected by the school. However, those textbooks are made thinking of a different target population and they end up being inadequate for the local needs. Therefore, as Montijano (2014) mentioned “teachers can counterbalance or offset any deficiencies of the textbook. Teachers’ resourcefulness in this sense is vital to improve what the textbook does not provide adequately. By resorting to any kind of supplementary materials” (p. 14). This resourcefulness can respond only to the need from the moment, and as teachers we design, adapt or use materials without the theoretical background necessary for such materials to fulfill the pedagogical or didactic main goal.

One type of materials corresponds to the teacher-made materials, which refer to the ones designed by the teacher for a specific context or group needs. As Núñez et al. (2017) affirmed “teacher-developed materials fit into the category of contextualized materials that are context-bound since they are responsive to local needs” (p. 34). On the same matter, Montijano (2014) stated, “It takes time, effort and unquestionably makes tough demands of practitioners who must hold both the awareness and understanding of the manifold interwoven variables affecting teaching theory and practice” (p. 15). On this regard, Ur

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

(1996) affirmed that “good teacher-made materials are arguably the best are: relevant and personalized, answering the needs of learners” (p. 192) As suggested by the scholars it requires preparation and to make a clear difference between creating, adapting or modifying them as well as the importance of using contextualized materials that respond to needs in a given context.

Another classification corresponds to authentic and non-authentic materials, which refer basically to all sort of materials used by the teachers with the main objective of helping students achieve comprehension and proficient use of language even if they were not created with pedagogical purposes. Scholars such as Montijano (2014) and Gilmore (2007) referred to authentic materials as any source that can be used to promote the improvement of the competences in the foreign language, although they are not designed for that particular purpose; in this case teachers can make use of them to achieve the understanding or communicative goal, commonly mistaken with the mere use of realia. Authentic materials include a variety of resources that teachers mostly adapt or incorporate in the teaching practice.

The goal of teachers when using this kind of materials is to contextualize learning environments in the real use of the language as Berardo (2006) claimed that “one of the main ideas of using authentic materials in the classroom is to “expose” the learner to as much real language as possible” (p. 64). On the same aspect Tomlinson and Masuhara (2010) asserted that “it is important to use authentic texts and tasks when developing materials, since this kind of materials stimulate language acquisition if they expose the students to real language in context and if they are used to make them communicate and to think critically” (p. 399). Considering the communicative purpose of the languages,

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

exposure is the closest students are to real situation within the classroom and gives the opportunity to practice in context.

This kind of materials are not meant to replace the textbooks since they have a different but equally important function in the language learning and teaching. Swaffar (1985), emphasized that, the objective of foreign language textbooks is to “teach language per se rather than to communicate information” (p. 17). On the same matter, Bailey (as cited in Huessien, 2012), said that “authentic materials are oral and written texts that occur naturally in the target language environment and that have not been created expressly for language learners” (p. 25). The idea of authentic materials would be then, to take the knowledge acquired regarding the language structures and use them as they would be used in any case out of the classroom.

On the other hand, we have non-authentic also called for some scholars as unauthentic materials which Montijano (2014) defined as “exercises and tasks designed by teachers to facilitate students’ involvement” (p. 15). These non-authentic materials are usually developed focusing on topics, units of content, grammar, or communicative skills (reading, writing, listening and speaking). The design and implementation of these types of materials usually consider the immediate needs of the teacher and respond to the lesson needs or are based on the textbooks teachers are required to use.

Independently from the type of material teachers decide to use, the research studies on the field provide the academic background to do such an important task with the responsibility needed. Therefore, it is compulsory to take into consideration the Second Language Acquisition principles proposed by Tomlinson as well as the theoretical frameworks that structure them.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

This research study was centered on the teacher-designed materials based on the observation and diagnosis made for the statement of the problem and students' needs, interests, weaknesses and strengths. The materials designed can be placed in the category of non-authentic materials and according to Tomlinson (2011), "Experiential (providing the learner with experience of the language in use), eliciting (encouraging the learner to use the language) and exploratory (helping the learner to make discoveries about the language" (p. 143). Being science class the space where the materials were implemented students were expected to show outcomes in the second language more than simply coping with a language learning program.

Having addressed the first theoretical construct that frames this study, the following section deals with problem-based learning.

Problem-based learning

Problem-based learning as a pedagogical approach. Problem-based learning (PBL henceforth) is a relatively new approach. However, many educators around the world are showing their interest in such innovative approach.

PBL can be defined as an approach in which "students meet an 'ill-structured problem' before they receive any instruction. In the place of covering the curriculum, learners probe deeply into issues searching for connections, grappling with complexity, and using knowledge to fashion solutions" (Stepien & Gallagher, 2001, p. 50). This approach, however, is more complex than simply solving some domestic situations; it encourages and prepares learners to face the real world based on the skills and abilities they develop throughout their school years.

The curriculum based on contents and thematic syllabus does not represent students' needs or interest. According to Bloud and Feletti (1997), PBL "is an approach to

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

structuring the curriculum which involves confronting students with problems from practice which provide a stimulus for learning” (p. 15). In this definition, it can be understood that turning the learning process into a meaningful and worthwhile path is the main objective to be achieved by this approach.

Since PBL focuses on situations students feel familiar with, it represents a great opportunity to engage them in their learning process due to the fact that it “helps to maintain student interest in course material because students realize that they are learning the skills needed to be successful” (“Stanford University Newsletter on Teaching”, 2001, p. 3). Once students find a useful and reachable objective to attain, they use all their potential to obtain the best result possible. This research study was focused on using this motivation aspect from the PBL as one of the main factors in the design and implementation of the teacher-designed materials.

Historical framework. PBL origins could be traced all the way back to Dewey who in 1930 working for the University of Chicago proposed the idea that “learning is more interesting if the learner is actively involved in his own learning” (Schmidt, 2012, p. 25). This intrinsic interest meant to make meaningful projects that students could develop and apply in their own lives. Another influence for the development of PBL was Bruner’s learning by discovery. Referring to the work of Bruner, Schmidt stated that “learning by discovery stimulates a deeper insight into reality, increases skills in thinking, fosters intrinsic motivation to learn, and facilitates the assimilation and retention of information that has acquired personal significance to the learners” (2012, p. 26). This background on PBL history shows how educators have been looking for ways to promote the involvement of students in their own learning process.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

In more recent history, this search for meaningful experiences in which learners could apply what they know began as a technique used in medicine schools back in the 70's as a way to prove how medicine students could solve practical and possible real-life situations by using their medical skills and as a team. In the 90's it was implemented as a teaching method in regular academic contexts ("Stanford University Newsletter on Teaching", 2001, p. 1). In this regard, this approach is an innovation in education product of decades of research; and as such, it is a need for us as educators to learn the proper way to implement it.

Teachers and students' role in Problem-based learning. As part of the development of materials based on this approach, it is fundamental to consider what the role of each of the actors in class is. According to the Othman and Ahamad, M. (2013)., "PBL is an approach that involves no teaching; students learn by solving problems that are carefully constructed by the teacher according to the course syllabus assigned" (p. 2). Likewise, Bound and Feletti (1997) considered that "PBL is not a teaching method but a way of learning" (p. 15). Consequently, it requires a teacher who has high preparation in developing materials according to the course, and students who are able to solve the problems stated to learn according to the objective set. It implies a great level of commitment and responsibility from teachers, who should accomplish the syllabus needs and design materials to help students to develop the needed skills to solve the proposed problems and those out of the curriculum.

As part of the preparation of the materials, teachers must have clear what is expected from them as facilitators of the learning process of students. As Boud and Feletti (1997) highlighted:

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The teacher facilitates the process by putting the students in groups, scheduling presentations and preparing evaluation forms for the students to evaluate themselves and their peers, in addition to teacher evaluation. In PBL, the problem comes first, and an essential element of PBL is that content is introduced in the context of complex problems that imitate real life. (p. 34)

In other words, students learn by doing and being exposed to real-life problems in which they must identify and evaluate what they need to know to be able to come up with a suitable solution, which is the case of the pedagogical intervention proposed for this study, since students guided by a question and facing the process of planting their seeds, comparing, contrasting and registering information deal with several variables they needed to foresee and elaborate possible outcomes.

Hitherto we have discussed the Problem Based Approach as the second theoretical foundation supporting this study. In the next section, I address inquiry skills the third theoretical construct that informs this study.

Inquiry Skills

Focus on guided inquiry. Teaching has evolved from the early traditional approach, in which students were in charge of receiving the theory from the sciences, to the constructivist theory in which the learning process requires an active role from the student. However, the transition to identify what students needed to do when learning brought a series of changes in the objectives and methods used. One of the first attempts was Dewey's phases of reflective thinking; the author explained that "facts, data, and information arouse ideas that enable the learner to make inferences from what he or she already knows that lead to deeper understanding" (Kuhlthau, Maniotes, & Caspari, 2007, p. 15); based on this, the process of reflective thinking, which is divided into phases, led

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

students into using their feelings, doubts, and actions in the resolution of situations that made them suggest, infer and conclude.

Nonetheless, it was a phase of guided inquiry that focused all the efforts in what was called the Information Search Process, and therefore, in the mere gathering of data and analysis of it from the students' perspective.

Principles of guided inquiry. The representatives of the constructivist school, Dewey and Bruner, agreed on the fact that learning was an active individual process; nonetheless, Bruner suggested that the learning process “involved in making sense of the worlds, and they need to be involved in interpreting for deep understanding to occur” (as cited in Kuhlthau, Maniotes, & Caspari, 2007, p. 25). Moreover, from the beginning of the inclusion of inquiry skills in the learning process, they suggested six principles for the teacher as a fundamental part of the guided inquiry process to be developed successfully. Kuhlthau et al. (2007), stated the following:

Children learn by being actively engaged in and reflecting on an experience; children learn by building on what they already know; children develop higher-order thinking through guidance at critical points' in the learning process; children have different ways and modes of learning; children learn through social interaction with others; children learn through instruction and experience in accord with their cognitive development. (p. 25)

Observing these principles I can relate them to the current method of teaching subjects such as science, which was the main concern on this study, and considering the importance and the positive effect on students' lifelong learning, it was relevant to be studied to implement strategies aim to have a positive impact on the sample groups.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Teaching science through inquiry skills. Due to the features of the inquiry process, international programs have implemented and modified the use of syllabus that focus on inquiry skills for a long time. Indeed, subjects such as science and math offer the possibility to integrate students' background and hands-on class studies to keep students interested and active in the classes.

The Cambridge program suggested six stages, one for each school year, for the teaching of science in elementary school. These stages focus the across program on the development of inquiry skills; therefore, the strands such as physics, chemistry, biology, environmental sciences, and botanic, must include the inquiry skills that were selected to be developed in each of them. The central idea consists of students to have a scaled process to develop especially their skill processes of observing, predicting, interpreting, and communicating results (OPIC). These skills do not follow a unique order in the inquiry process, they happen in different moments and some are even repeated according to the student' needs until they achieve their expected results.

The observing process refers to watching carefully, taking notes, comparing and contrasting; as stated by Ash (1999), "observation of real phenomena begins the inquiry process and continues throughout all its phases" (p. 53). Observation implies involving all the senses in the process, identifying details do not only depend on the sight, but on perceptions we have of the world and the memory that has been settled with the use of the hearing, smell, touch and taste. In the process of developing observation those perceptions of reality can enrich the evidence gathered.

The predicting process suggests an event that might occur based on the observations, this is usually guided by questions or throughlines, this term is referred in the Harvard School of Education and the Teaching for Understanding Guide by Tina Blythe.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

On the subject of inquiry, to focus the exploration of generative topics, teachers can develop nested understanding goals - that is, unit-sized goals embedded within year-long overarching goals, or throughlines. Ash (1999), stated that “this process takes away the need for guessing...typically, a prediction is based on evidence from past knowledge and/or experience, and upon immediate evidence gained through observation” (p. 56). The prediction of the event to come might guide the student in the right track, it deals with mental processes of association and making connections.

For interpreting, the student must work on his ability to synthesize, and get to simple conclusions by identifying patterns or reading simple data. Ash (1999), described the process as “making associations between variables and making sure that the data support the hypothesized connections. It is critical to relate findings to initial questions and observations” (p. 57). Teachers as facilitators are in charge of helping students mature their potential along the inquiry cycle.

Finally, communicating results implies a variety of ways to inform about findings, considering the different learning styles, as stated by Ash (1999), “It also includes choosing the appropriate way [depending on students’ learning styles] to translate knowledge to others by making representations such as charts or diagrams, for example, that illustrate data and results” (p. 58). It allows the teacher to recognize and give greater value to individual learning.

To do so, the program suggests teachers to include patterns in their cycle planning, in which the process will flow from guided inquiry to application phase. Peters and Gega (2005) proposed three phases; an exploration that is student centered in which they interact with materials and each other; a concept introduction phase in which the teacher works with students to develop vocabulary and introduce pertinent information and finally a concept

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

application phase that allows students to apply freshly learned information to new situations.

According to the description of OPIC phases, they serve as the basis for teacher's cycle planning, to facilitate and center their efforts in providing the materials; solving doubts; and creating the appropriate environment for students to develop the process and solve the situations. In the end students are able to apply what they have learn both, in the subject as such and in different real life situations. As it was proposed in this research study, the way to help students improve the four selected skills OPIC must consider factors in which the attention is centered on students' needs, contexts, and the possibility to solve problems which will scaffold them in the resolution of some others they find in several subjects and life situations.

This process and the development of the inquiry skills empowers students to foster their leadership since they are in charge of solving situations and eventually use their skills in and out of the school context, they are facing situations in which they are not guided by the teacher and in which they need to use their skills to be able to develop the worksheets and to predict and communicate, it is also important to point out that students are addressing science by experimenting but also by reading, writing, using sources of information and becoming eventually communicators of their own findings.

Having addressed the theoretical constructs that support this research study on the following part I present the methodological design of the pedagogical intervention.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter III

Methodological Design

In this chapter I present the foundations of the methodological design that includes both the research and the instructional designs that support this study.

Research Design

The research design includes the approach and type of study, the participants, and the data gathering instruments. The instructional design describes the pedagogical intervention and its general and specific objectives, the issue of innovation, the theory of the nature of language and language learning, the methodology underpinning the intervention, the relation between the research inquiry and the pedagogical intervention, the instructional phases and the sample worksheet.

As stated in the previous chapters the purpose of this research study is to develop and implement teacher-designed materials focused on a problem-based learning approach to develop students' inquiry skills.

Research approach. The approach followed to conduct this research is the qualitative approach. As stated by Lankshear and Knobel (2004), "Qualitative research is centrally concerned with how people experience, understand, interpret and participate in their social and cultural worlds" (p. 68). This kind of studies focuses on the observation and description of a real sample, real situations and the way the participants perceive it. Authors such as Lichtman (2013), Marshall and Rossman (1999) also emphasized on the real people and natural settings as the main characteristic of a qualitative approach as well as the pragmatism to use multiple methods to gather the necessary data for this type of research. The research study fulfills the conditions mentioned above to be considered a qualitative study.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Type of study. The type of study that I carried out is action research. As contended by Mills (as cited in Mertler, 2009), it is “any systematic inquiry conducted by teachers, administrators, counselors or others with a vested interest in the teaching and learning processes” (p. 4). In this study students and the immediate context are the main concern. In this regard, Burns (2009) also pointed out the need of teachers’ reflection on their specific social situation in the school or classroom. Authors such as Burns (2009) and Elliot (1991) agreed on the effectiveness of action research reflected on the teachers’ practice, and the positive educational outcomes that result from the process of planning, implementing and reflecting to continue making changes aimed to alleviate or improve the research concern. This research study focuses on the improvement of specific skills which will also contribute to the improvement of my teaching practice.

The following chart shows the cycle of an effective action research according to Burns, (2001) and was the base sequence taken as a reference point for this research study.

Diagram 1

Action Research Cycle (Burns, 2001)

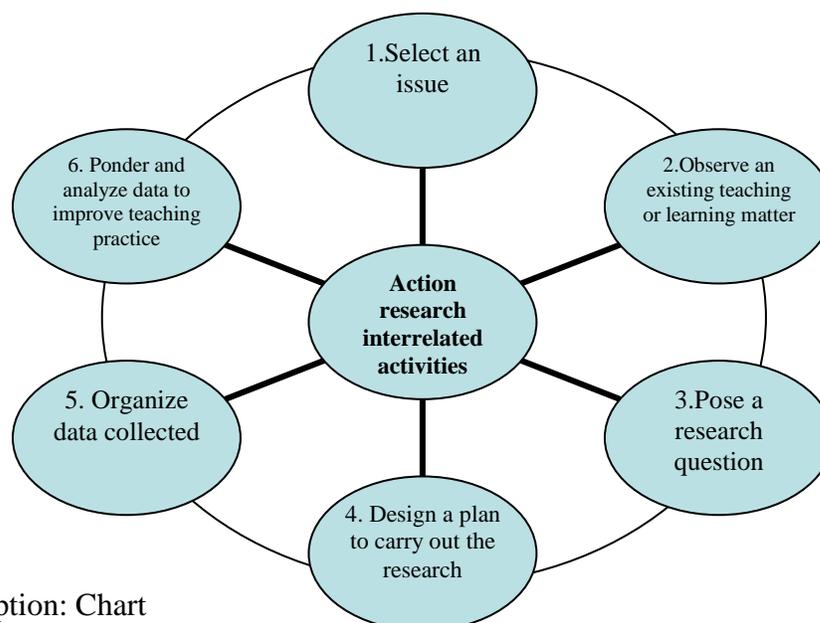


Image Caption: Chart

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Participants. The participants of this research study are a group of second grade students and myself as a teacher-researcher and materials developer.

Students. The students selected for this study are second graders from a private school. The group consists of 24 students equally distributed between boys and girls, whose average age is between eight and nine years old. These students have a proficient use of English language and in their academic program they are immersed in science and math classes also in the foreign language with an intensity of seven hours a week each. I used the convenience or purposive sample technique, in which the participants, as mentioned by Potter (1996), “are relevant sources of evidence of the phenomenon to be studied” (p. 107). Besides, Stevens (1999), affirmed that “the participants are chosen, based on the convenience of the researcher; for example, due to the availability or accessibility” (p. 187); which highlights the availability of the sample due to my proximity for being their science teacher. It is worth mentioning that students in the group decided to make part of the study and their parents signed the informed consent letter (See Appendix B).

Teacher-researcher and materials developer. My participation as a teacher includes my responsibility for fulfilling the teaching objectives of the curriculum and the design of the planning considering the curricular guidelines of the science program at the Gimnasio Colombo Británico. In action research, the researcher becomes part of the context being studied (Hammersley & Atkinson, 1983); thus, my role as a teacher was to guide, motivate and facilitate learning through innovative experiences. As a teacher-researcher I conducted a needs analysis, gathered information while implementing the pedagogical intervention of the study, interpreted, reduced it and established the research categories and analyzed of the results. As a materials developer, I designed and implemented the materials

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

to help my students accomplish their goals considering their language learning and affective needs, the SLA principles relevant to the development of materials, and proposed a theoretical framework for MD (Graves, 1997; Núñez et al., 2009; Tomlinson, 1998). The role as a researcher and materials developer required a theoretical background and commitment towards the process of my students and the goals of the research study.

Data gathering instruments. The collection of information is a crucial part of any research study. Due to the research approach and the type of study defined for the current investigation, the instruments to collect data for this research study were students' artifacts, field notes and a focus group interview. These instruments were previously piloted with a group of similar characteristics to the sample so that they were adjusted and modified when necessary. Nevertheless, it is also important to mention that the needs assessment survey was used to ratify the problem and to develop the teacher-designed worksheets.

Students' artifacts. During the research study, there were some existing documents that must be considered as first-hand information. Among those documents, according to Mills (as cited in Mertler, 2009), "The classroom artifacts include any written or visual sources of data, contained within the classroom, that contribute to our understanding of what is occurring in classrooms and schools" (p. 114). Therefore, what is sometimes called students' evidence or products are a tool to collect relevant information. Artifacts are usually classified as written data that "are generated by participants during a study that are relevant to the researcher's questions but have been independently of participation in the research" (Lankshear & Knobel, 2004, p. 176). Such artifacts were useful in the analysis of the development of inquiry skills in different and real contexts, since they are first-hand evidence of the achievements of students.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Field notes. This instrument is mainly designed to gather information related to events that have been observed in the process. For this research study, I developed a Field Notes format (See Appendix C) that permitted the analysis of what I had observed in relation to the research question and objectives. Lankshear and Knobel (2004) referred to field notes as “written in the heat of the moment as events unfold before the researcher’s eyes and tend to be the primary data collection tool during observation” (p. 229). This instrument allows the researcher to go over details and not miss information that could be relevant in the analysis of the events.

The importance of observation and field notes as instruments for data collection can be understood by acknowledging some scholars’ insights. For Hargreaves and Hopkins (1994) the observation is a priority in the field work in regard to the development of education research that pursues the change or improvement. In addition to this, Schmuck (as cited in Mertler, 2009), points out the importance of observation to be careful and systematic. The relevance of field notes, as instruments to collect information, relies on the fact that “as you make observations over time, patterns will begin to emerge from the data you have collected” (Mertler, 2009, p. 107). Arhar et al. (2001) affirmed that field notes are “direct observations of what is being said and done as well as impressions or hunches of the observer” (p. 140). During the process of observation and taking field notes I could identify important information that was relevant in the analysis of the class events.

Focus group interview. As important as collecting data from the worksheets and the observations it is to know what the perception of the participants is. According to Lankshear and Knobel (2004), focus groups are methods “for accessing alternative points of view, for obtaining insights...and for clarifying the researcher’s in-process interpretations garnered or developed from already collected data” (p. 208). It can lead to

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

modifying, correcting or ratifying the path the researcher has taken to a certain point of the process.

In addition to this, the focus group offers some other advantages, Lankshear and Knobel (2004) stated that it “can help teacher researchers maximize data collection within decreasing research time frames” (p. 208). Thus, any instrument that can improve time constraints is a useful one. Which in the case of this research happened due to the numerous activities school organizes and sometimes might interfere with the implementation process.

Instructional Design

In this part of the chapter, I present the instructional design of this research study, which explores the development and implementations of teacher’s designed materials focused on the Problem-based Learning (PBL) approach to improve the inquiry skills of second grade students. The content presented consists of the pedagogical intervention; specific and general objectives; innovation of the intervention; the theory of nature of language and language learning; methodological method and approach; the relation between the instructional design and the research question; the instructional phases developed to implement the pedagogical strategy; the topic selection and development, and a sample of the worksheets used in the pedagogical intervention.

Pedagogical intervention. The pedagogical intervention of this study entails developing and implementing worksheets to improve inquiry skills through problem-based learning approach in second graders at a private school.

The teacher-designed materials are six worksheets with their corresponding self-assessment. The worksheets are designed considering three main moments: there is a moment in which the teacher can find out students’ prior knowledge. This is called the exploration stage, also known in some approaches as the pre-activity. During the guided

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

inquiry stage, also called while-activity, the teacher introduces concepts, the names, relevant details and events to guide students; the teacher's function is to provide or guide students to obtain relevant information. During the independent inquiry, which is student centered, also called post- activity, the teacher allows students to apply discovered and learned information to try to solve the proposed situation. Finally, in a synthesis stage, students propose a way in which what they have learnt can be applied to new or different situations.

Teachers as developers must be aware of the impact materials have on the learning process of students, and the way they are designed and implemented must rely on a theoretical background that combined with the teacher expertise can achieve the main educational goal. As mentioned by Rico (2005), "There are a few specific books in the field of English language teaching which focus on materials selection and evaluation in detail, which makes it difficult for teachers to deal with such an important aspect" (p. 1). Therefore, we must look for the relevant sources and studies that can give theoretical support to such an important task.

Language teaching materials are ruled / governed by SLA tenets, scholars like Tomlinson (cited in Núñez, Téllez, Castellanos and Ramos, 2009), made an important contribution for EFL teachers in relation with the Second Language Acquisition (SLA hereafter) principles as from which I have selected eight I consider more relevant to this study. The first one refers to learning environment: "Materials should help learners feel at ease. SLA research has revealed that students seem to learn more and in a shorter time when relaxed and comfortably engaged in learning activities" (p. 43). The intrinsic motivation depends also on the elements we provide our students with for them to feel ready to learn.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The second principle that emphasizes on the significance or what students perceive as relevant and useful, is one of the main goals of this study. Since it is going to address problem-based situations in students' real contexts, it is one of the main concerns to observe and identify issues that students find significant. Considering the high proficiency level of English by the target population of this study and the interest of the Research Line of the Emphasis on English Didactics in fostering the explicit model of strategy instruction, the third principle aims to "facilitate student self-investment, which aids the learner in making efficient use of the resources to facilitate self-discovery" (p. 43) was favored. Such principle promotes both autonomous learning and the reflective aspects of using science language to express what the learners infer and conclude as part of the third theoretical construct of this research study. The nature of the development of skills such as predicting matches another SLA principle. It states the need to "provide opportunities for communicative purposes in L2, thereby fostering language use, not just usage" (p. 44). To make it possible it is a must to get to know what students want and need to communicate and their strengths and weaknesses to be able to do it in an effective and accurate way.

In respect of the existing differences in students' learning, the fifth principle reads "students' different learning styles such as visual, auditory, kinesthetic, analytic, experiential, global, dependent, independent, etc." (p. 44). This leads teachers to identify students' learning styles through conscious observation of the class and by systematizing and analyzing the information gathered.

I consider the English language skills as important as the thinking skills from which I focused this research on the inquiry skills: observing, predicting, interpreting and communicating (OPIC hereafter). An additional principle is to "stimulate left and right brain lateralization through intellectual, aesthetic and emotional involvement" (p. 44).

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Therefore, the materials designed and implemented contemplate the intellectual challenge investment, aesthetic appealing perceptual and emotional motivating involvement.

The science class also provides the opportunity to implement the principle referred to free practice to allow students to have a long-term effect as well as the opportunity for outcome feedback. Due to the nature of the science subject and the variety of activities and learning objectives of the school approach (Teaching for Understanding) it is possible to move from guided practice to independent work, with both, permanent ongoing formal and informal evaluation.

Each worksheet has a name in reference to the topic covered and all topics centered in the orchard project; the first one is called *Our first visit to the school orchard*, the second *Planting our seedbeds*, the third one *Saving the planet one plat at a time*, the fourth *Seedlings to the Ground*, the fifth *Measuring and taking care here and there*, and the sixth *Harvest time is cooking time*.

The self-assessment included questions referring to the constructs related to this study and SLA principles. Mertler (2009), insisted on the importance of the characteristics of effective self-assessments, to keep the objectives clear, use vocabulary students feel familiar with, and revise the relevance of the questions, among others. Accomplishing those characteristics was relevant for the design of the self- assessment which enlightened the modifications necessary for the development of the materials used for the research study.

An effective way to find out the appropriateness and usefulness of the materials designed was the first piloting instrument; according to Mertler (2009), on the acting stage of the action research, most of the data that is gathered helps the researcher to analyze, modify or adapt the designed materials so they can accomplish the research goals.

Throughout the development and implementation of the piloting materials, besides the

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

observation and field notes described before, I included a self- assessment in which the students from a pilot group helped with their perception to evaluate and improve the materials.

General and specific objectives. The main objective of the pedagogical strategy was to design and implement six teacher's designed worksheets for improving students' inquiry skills. To do so, I developed the worksheets under the PBL approach and relying on the science syllabus stated for second grade at a private school.

Three specific objectives were stated for the current study: (a) to promote learning environments in which students find the opportunity to solve problematic situations; (b) to make students aware of the importance of developing or improving their inquiry skills; and (c) to have students improve their inquiry skills and use them in real contexts.

Intervention as an innovation. One of the purposes of this research study is to be not only relevant but also innovative for the benefit of the target population as well as for the research line Materials Development and Didactics Ascribed to the Research Group: Critical Pedagogy and Didactics for Social Transformation. To begin with it, it is necessary to define what innovation is; according to Markee (2001), it "is the implementation and/or evaluation for new ideas and procedures" (p. 121). However, as suggested by Fullan (as cited in Markee, 2001) it is relevant to consider that one of the characteristics of innovation should constitute an improvement on previous practices; which reflects the importance of well-conceived and structured innovative materials.

It is precisely in the planning of the materials where the role of the teacher as developer is fundamental. As stated by Núñez, Pineda and Téllez, (2004), "Teachers as innovative professionals, have the potential to explore their creativity by designing materials for their classes" (p. 130). In words of Núñez, Téllez and Castellanos (2012),

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

“Innovative teaching materials that address students’ language learning needs and goals, increase attention, enhance motivation and boost effective learning” (p. 25). Such responsibility must be carefully developed throughout a formal process that might consider the particular needs of improvement and what has already been done to make sure it is not adaptation or modification.

This research study is innovative in several ways; first for me as a teacher researcher and materials developer. The teacher-designed materials offer the possibility to use the creativity, knowledge of the academic discipline, and theoretical background, focused on the planning, design and implementation of worksheets. It is also innovative for my students who will face materials designed especially for them centered in developing their inquiry skills for observing, predicting, interpreting and communicating. In addition to that, the use of the PBL approach in real contexts, represents an opportunity for innovation since, as mentioned by Boud and Felletti, (1997) it is a relatively new approach in education field that centers the attention in modeled situations rather than immediate and domestic problem solutions, which is one of the objectives of this research study.

Finally, the contribution that the process and findings of this research can make to the research line mentioned above due to the fact that the teacher-designed materials focused on the selected approach has not been widely studied in Colombia.

Theory of the nature of language and language learning. In reference to the nature of language, Tudor (2001) stated four visions; the linguistic, functional, self-expression, and cultural perspective. This research study does not focus on the linguistic since the target population has an accurate use of the English language. It reflects the functional perspective centered on the use of the L2 for a specific purpose in the Science class.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The self-expression perspective according to Tudor (2001), “Permits language learners find a sense of personal meaningfulness in their language study” (2001, p. 69). For this study, the way in which students communicate their OPIC (Observation, Prediction, Interpretation, Communication), relies on the way they can make use of communicative language, and on student’s needs and situations to solve through the PBL approach.

From the nature of language learning visions stated by Tudor (2001) I consider experiential and analytical learning the most accurate and relevant. The study of science in the Teaching for Understanding syllabus, establishes a learning of the language throughout vivid experiences in which the student develops guided and eventually independent activities, and learns the content and the ESP language of the subject itself.

Methodological approach. The methodological approach selected to develop this research study is the problem-based learning approach (PBL), which leads learners to face every situation using the skills and abilities they have developed along their school life. The PBL focuses on the process to solve a situation in which students follow some logical guidelines to provide what for them would be a suitable solution. In combination with the third construct of this research which is the development of inquiry skills the process was carried out considering Peters and Gega’s, (2005) contributions about the three stages for developing skills Exploration, Guided and Independent Inquiry which were addressed in the literature review of this document. Also, it was adapted to the school student-centered model for lesson planning in which the teacher is a facilitator, observing, questioning, and assisting students as needed. The students interact with materials and each other during the process.

Connection of the pedagogical intervention with the research question. This pedagogical intervention aims to respond my research question since as stated before, the

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

materials were supported by the SLA principles, structured under a contextualized framework of materials development and aligned with the PBL approach, which promotes the development of the inquiry skills. As it was envisioned by Richards (2005), “The first task to solve in planning a set of materials is to identify an acceptable set of principles to support the instructional design process” (p. 9). The principles mentioned by Richards promote the design of materials that “provide opportunities for learners to experiment and try out what they know” (p. 9). Such principle corresponds with the way that through PBL and stages of inquiry these worksheets have been developed.

Instructional phases. These phases include the proposed theoretical framework for MD, the informed consent, the sensitization and the implementation of the materials.

The proposed theoretical framework for MD. To develop my pedagogical intervention, it was necessary to analyze the different theoretical frameworks proposed in the MD field. Authors such as Graves (1997); Masuhara (1998); Jolly and Bolitho (1998); Núñez et al. (2004); Núñez and Téllez (2009); Núñez et al. (2009); Núñez et al. (2012), Núñez, Téllez and Castellanos (2017) agree on the importance of beginning the process with a needs assessment, considering the population of students and focusing on what they need, taking into account their context can provide valuable information for the development of the most appropriate materials. Graves (1997); Masuhara (1998); Núñez et al. (2004, 2009, 2012) also have as a common feature the selection of goals and objectives in which it must be determined the skills to aim at. Jolly and Bolitho (1998) consider an important part of the process the identification of a problem. Núñez et al. (2004) refer to the type of participation and activities required for students, as well as Núñez et al. (2009) talk about making adjustments when necessary.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Based on those frameworks, I proposed my own one, which consists of six stages as follows: Diagnostic survey to identify the interests and needs of the target population and their preferences among the class strategies usually implemented; setting objectives based on both the science and PBL approach; creation of learning activities featuring leadership; piloting the materials; appraising the materials, improving the six teacher-designed worksheets.

Informed consent. The institution authorized the implementation of this research study through an informed consent letter, as well as the parents of students as a legal requirement and under the condition of confidentiality. Both letters were signed in February 2017. The letters contained information about the purposes, procedures and expecting achievements of this research study and allowing them to participate voluntarily (See Appendix B).

Sensitization. It was necessary that students got to know the process they would be part of, and the possible outcomes as well as the stages they would be facing, therefore, I presented a power point presentation with the information related to the research study.

Implementation of the materials. I implemented six worksheets with three parts each (exploration, guided inquiry, independent inquiry). Each worksheet was implemented during three sessions, each session lasted 45 minutes. The design of the worksheets organized as a wide ruled workbook for each student, permitted students to keep track of their progress and to develop some of the activities at home according to the instruction given. It also favored the process of feedback. For each session, there was a moment to recall what had been done before and a closing moment; in other words, there was always time, at the end of the class, for group, pair or individual feedback.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Science classes were scheduled six hours a week. From which I took three sessions a week for the development of the study. The regular development of the class permitted the alignment of the study with the syllabus program, students had a routine in which for the first part of the class the teacher writes on the board the TL that would guide the session and they were familiarized with the inquiry stage and its title for the session. There was constant interaction and eliciting ideas as well as diverse group work either for sharing ideas or for receiving pair feedback. Each Worksheet (WS) was divided in three parts (exploration, guided inquiry, independent inquiry) which has a name that would be the name of the session. The chronogram shows six weeks of implementation starting in March 2nd and finishing April 21st.

Table 1

Worksheets Chronogram

Worksheets	Session1 Exploration Stage	Session 2 Guided Inquiry	Session 3 Independent Inquiry
<i>WS No.1 Our first visit to the school orchard.</i>	<i>Scavengers hunt</i>	<i>I spy with my spy eye</i>	<i>Our place to plant</i>
	Session 4	Session 5	Session 6
<i>WS No.2 Planting our seedbeds.</i>	<i>Ready Set Grow!</i>	<i>The closer the better</i>	<i>I see, I know, I think</i>
	Session7	Session 8	Session 9
<i>WS No.3 Saving the planet one plat at a time.</i>	<i>My planet my garden</i>	<i>Don ´t put all your veggies in the same basket</i>	<i>An image speaks louder than a thousand words</i>
	Session10	Session 11	Session 12
<i>WS No.4 Seedlings to the Ground.</i>	<i>Jack what ´s Up with the magic beans</i>	<i>Moving to a new home</i>	<i>Let it grow, let it grow</i>
	Session13	Session 14	Session 15
<i>WS No.5 Measuring and taking care here and there.</i>	<i>Organized ideas flow</i>	<i>Are you a good fortune teller?</i>	<i>An apple a day keeps the doctor away</i>
	Session16	Session 17	Session 18
<i>WS No.6 Harvest time is cooking time.</i>	<i>Roots Stems Branches Leaves</i>	<i>May the force be with you</i>	<i>Delicious and Nutritious</i>

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Each worksheet was given an engaging name, and each stage was also named according to the activity proposed. To make it clear I will describe the main inquiry question (throughline TL here after) that guided each worksheet:

WS No. 1 TL: What do plants need to grow well in a wetland ecosystem?

WS No. 2 TL: What do I need to plant the seedbeds?

WS No. 3 TL: How does our orchard help the planet?

WS No. 4 TL: What do you expect to happen with your seedlings?

WS No. 5 TL: How do variables affect the plants' growing?

WSNo.6 TL: How have I improved in my inquiry skills leading this project?

Sample worksheet

Our first visit to the school orchard

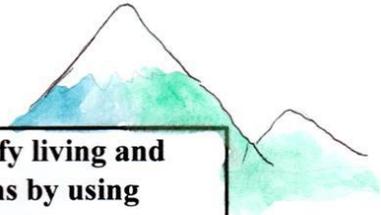

Throughline:

What do plants need to grow well in a wetland ecosystem?

We have already learnt the different kinds of ecosystems and the elements that are part of each of them. Today we will OBSERVE and register our observations about our school wetland ecosystem.

Exploration stage: Scavengers hunt!

1. Visit the places you find in the chart. Identify living and non-living things. Register your observations by using drawings, list of words, pictures or all of them.

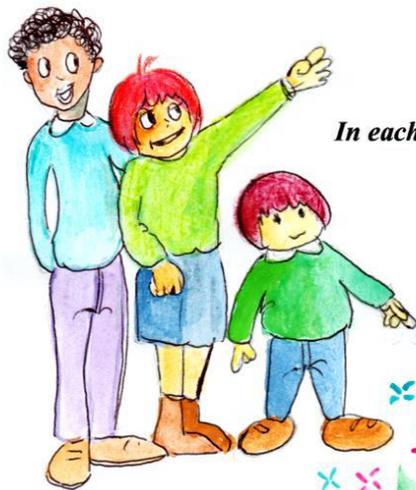


Remember!

Good observers use all their senses.

Be attentive to hidden details!

In each place you will also find a hidden word.



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Metacognitive Strategies: Selective attention; deciding in advance to attend specific aspects of language input.



a. The flowers garden in front of your building.

Hidden word #1 _____

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b. The pre-school playground.

A large, empty rounded rectangular box with a green border, intended for a drawing related to the pre-school playground.

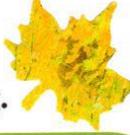
Hidden word #2 _____

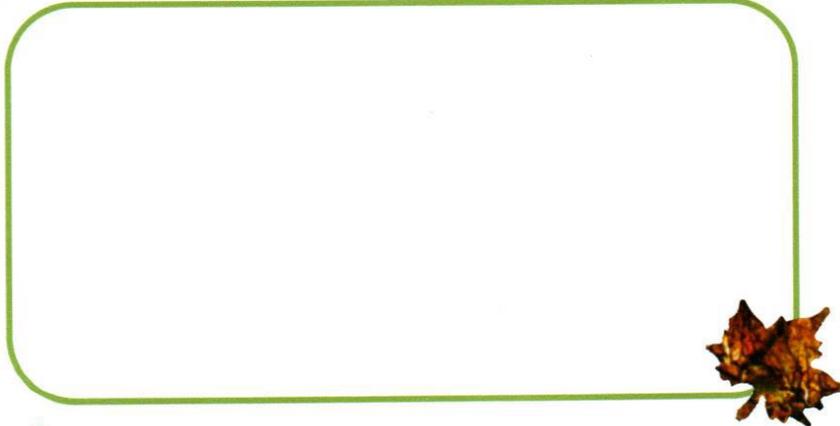
c. The covered soccer field.

A large, empty rounded rectangular box with a green border, intended for a drawing related to the covered soccer field.

Hidden word #3 _____



 **d. The orchard behind the library building.** 



 **Hidden word #4** _____

Make a sentence using the four hidden words!  

 _____ 

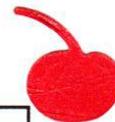




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Guided Inquiry stage: I spy with my spy eye!



2. In groups of three students discuss the following questions. Then write some ideas about your answers in the space provided.



Remember!

Scientist talk using science language.

Listen to your partners to complement your ideas!

Cognitive strategies: Contextualization; Placing a word or phrase in a meaningful language sequence. Elaboration; relating new information to other concepts in memory



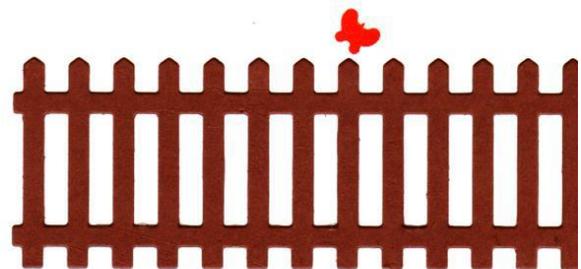
PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

 a. Which ways did you use to register your observations?

 b. Why did you select that way to register your observations?

 c. Do you think it is important to use real colours? Why?

 d. How can details help you express what you observed?



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- e. Complete the map to explain how your senses helped you find important details or if they did not. You can use words or drawings.

	 sight	
 hearing		 smell
 touch		 taste



Independent Inquiry stage: Our place to plant!



3. You already visited the place where the school orchard will be. According to what you saw and what you know about plants complete the chart on the next page.



Remember!

Farmers must consider different factors before planting.

Problem solving strategies: Explain or replace unknown terms. Ask questions to clarify or verify concepts.

Remembering: Group or classify; new terms into meaningful categories.



PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS



Factor	Condition	What plants need	Possible difficulties and leading solutions
Soil			
Weather			
Temperature			
Any other you can remember?			



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PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Self-assessment: Please read and answer the following self-assessment about the orchard worksheet.

Your answers are very important to check and improve the materials

My worksheet...	It does	It can be better
offers a variety of ways to share what I observe.		
has an attractive design.		
has a useful content.		
considers my needs, preferences and learning styles.		
promotes the application of learning strategies that help me do or solve the tasks.		
sequences the learning activities gradually so that I can learn in a relaxed way.		
provides opportunities to learn from both my classmates and teacher's observations.		
Observing around school ...	It does	It can be better
helps me identify and explain the elements I found in the orchard and around it.		
lets me describe in detail the possible needs to develop the orchard project.		
lets me compare what I know with what I need to know before advancing in the orchard project.		
To develop my inquiry skills...	I do	I can improve
I try different ways to register what I observe.		
I differentiate relevant from irrelevant details that can contribute to identify the needs.		



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PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter IV

Data Analysis

The purpose of this study was to reveal how the implementation of teacher designed materials on a problem-based learning approach contributed to the development of Observation, Prediction, Interpretation and Communication inquiry skills on a population of students who are proficient in the use of English as a second language. This chapter describes the process carried out to analyze the data gathered, as well as the findings of this research study.

Data Analysis Procedure

Once the data was gathered, the need to synthesize and analysis emerged. As defined by Creswell (2012), qualitative data gathering implies "working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others" (p. 145). The data analysis implies therefore, a laborious step by step process that eventually leads to answer the research question.

Based on the type of study, I selected the grounded theory as a methodological approach. This approach in qualitative research "allows for identification of general concepts, the development of theoretical explanations that reach beyond the known, and offers new insights into a variety of experiences and phenomena" (Corbin & Strauss, 2015, p. 6). Which means in this case the development of new theory based on the data collected. On the same matter Freeman (1998), affirmed that in the grounded approach, the data are collected "to look for meanings that surface through the process of naming, grouping the names into categories, and finding relationships among them" (p. 108). On this matter Willing (2013), emphasized that "grounded theory as method provides us with guidelines

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

on how to identify categories, how to make links between categories and how to establish relationships between them.” (p. 70). Such relationships entailed the finding of categories and subcategories and an effective use of the data gathered with the instruments selected and described in the previous chapter.

As mentioned in chapter three, the data was collected by using three different instruments; students’ artifacts, field notes and focus group interview. After gathering all the information from the instruments, I developed a process of reading several times, transcribing the field notes into digital document as well as transcribing the interviews carried out to the sample population.

Once the process was double checked I started organizing and identifying recurrent patterns. In words of Charmaz and Henwood (2008), “We gather data, compare them, remain open to all possible theoretical understandings of the data, and develop tentative interpretations about these data through our codes and nascent categories” (p. 241). According to this procedure the next logical step was to go over the patterns and define the emergent categories. Then, it was fundamental to work on the data by coding it and eventually being able to categorize.

The method I selected to code was the color coding technique, which according to Stottok, Bergaus and Gorra (2011), “Uses coloured fonts to assign certain codes, concepts and categories to the text, with codes being keywords or short sentences, concepts being interrelationships of codes, and categories being interrelationships of concepts” (p. 1). This way, I could organize the data keeping in mind the theoretical constructs and objectives of this research and as mentioned by Burns (1999) “attempting to reduce the large amount of data that may be collected to more manageable categories of concepts, themes or types” (p. 157). Especially considering that some of the data collected by means of instruments such

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

as the field notes might include information not relevant for the study since the field notes are taken in the moment of implementing the materials and it is necessary to verify and analyze afterwards.

With the purpose of strengthening the validity of the data analysis, I triangulated the information. As mentioned by Bitsch (2005), “Data triangulation refers to using a variety of data sources instead of relying on a single source” (p. 10). On the same matter Denzin (1989) established four different kinds of triangulation: *data triangulation* which involves the use of several kinds of sources, *investigator triangulation* which involves different researches in the process of analysis and finally, *theory triangulation* which involves the use of different theoretical perspectives. Considering the nature of this study and the instruments of data gathering, I used the methodological triangulation, and since I referred to different theoretical sources, I applied the theoretical triangulation. By using these ways of triangulation, the theory emerging from the analysis is not bias and therefore, it is reliable.

Research Categories and Subcategories

The categories I identified and their correspondent subcategories emerged as product of the analysis of the instruments, and they are presented in the following chart.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Table 2

Categories and Sub-categories for the Research Question

Research question	Categories	Subcategories
What does the implementation of teacher-designed materials focused on a Problem Based Learning approach reveal about inquiry skills in second graders at a private school?	Attaining practicality, particularity and communicative goals in sequenced teacher-designed materials .	Sequenced materials that favor students' preferences for achieving communicative goals
		Practicality and particularity of materials through independent practice
	Benefiting from PBL strategies to identify and solve problems	Identification and description of elements and situations to find needs
		Comparison strategies lead to suitable outcomes on problems
	Enhancing inquiry skills	Observation and prior knowledge bases for accurate prediction.
		Appropriate interpretation of data supports different way of communicating results

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Attaining practicality, particularity and communicative goals in sequenced teacher-designed materials. This category emerges from the impact that teacher designed materials had on students. The worksheets were guided by the second language acquisition principles and oriented to achieve the goals in terms of development of inquiry skills based on a PBL approach. However, being the students the center of the process of implementation, materials were thought for them to find them attractive, useful to their needs and interests. Kumaravadivelu (2003) introduced the concept of the “postmethod pedagogy as a three-dimensional system consisting of pedagogic parameters of particularity, practicality, and possibility” (p. 35). Referring mainly to students’ contexts, and finding materials useful and relevant. The concepts of practicality and particularity that entail this research will be addressed in the subcategories.

Continuing with the principles that entail materials designed, Núñez and Téllez (2009), mentioned that, when designing materials, it is important “to keep a balance among students’ language learning needs, preferences, motivations and expectations, their affective needs, and the institutional policies” (p. 173). Following some principles to design materials helped me to develop them trying to keep the abovementioned balance.

As teacher researcher and materials developer, it was essential to design the worksheets under the guidance of theoretical support. As mentioned by Núñez et al. (2017), “Teachers rely on the knowledge they have built and on the core of the beliefs that they have constructed throughout their teaching experience, which influences the way they conceive teaching as a learning process” (p. 25). Therefore, it is necessary to bear in mind that not only theory and experience are necessary when developing materials, it is a sum of the knowledge we have from our students in the everyday practice and the process of

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

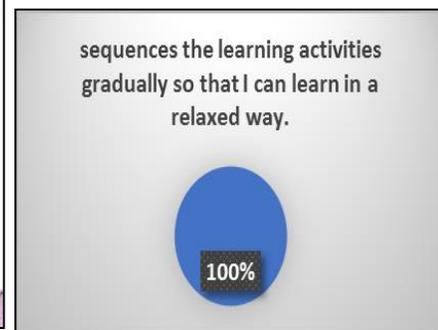
designing, piloting, correcting and final product that could show evidence of the SLA principles that guided them.

Sequenced materials that favor students' preferences for achieving communicative goals. This subcategory deals with the impact the materials had on students. The determining factor of materials being designed exclusively for them and their orchard project plus the freedom they had at certain point to show the way they preferred to present findings, helped students feel at ease and be truly involved in their own learning process. The way materials were structured helped students to move from the exploratory to guided inquiry and finally to the independent inquiry stage.

The following are excerpts from the data gathered through the instruments selected for this study. They show how materials were presented in a well organized sequenced way.



(Students artifacts worksheet N°4)



(Self-assessment worksheet N°4)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

This page from the students' artifact shows a sample of the way students find the materials sequenced, with clear instructions and strategies that guide them through the process. The self- assessment for all the students who were part of the sample showed that all of them consider the worksheet sequenced the learning activities gradually so they could learn in a relaxed way.

The way on which sequenced materials facilitate students to handle them was also reflected on the field notes as shown in the following excerpts.

Students are very excited about having their own booklet. As soon as they take it they explore it and check at the drawings and different graphs. The general comment is that it is beautiful and some ask if the teacher drew the images. Students who draw take longer than those who write, students are in a hurry to plant their seed beds. Student have clear why they choose a way or the other to complete the task.

They are familiarized with the material, it is structured in and although tittles and names of the stages are different, students already know where to find the instructions where to find strategies etc. self-investment making efficient use of resources to facilitate self-discovery. And materials that make students go easily through them making them feel at ease. [sic]

(Field notes worksheet N°2)

In the first part, I didn't understand the instructions but then the other parts were easy. [sic]

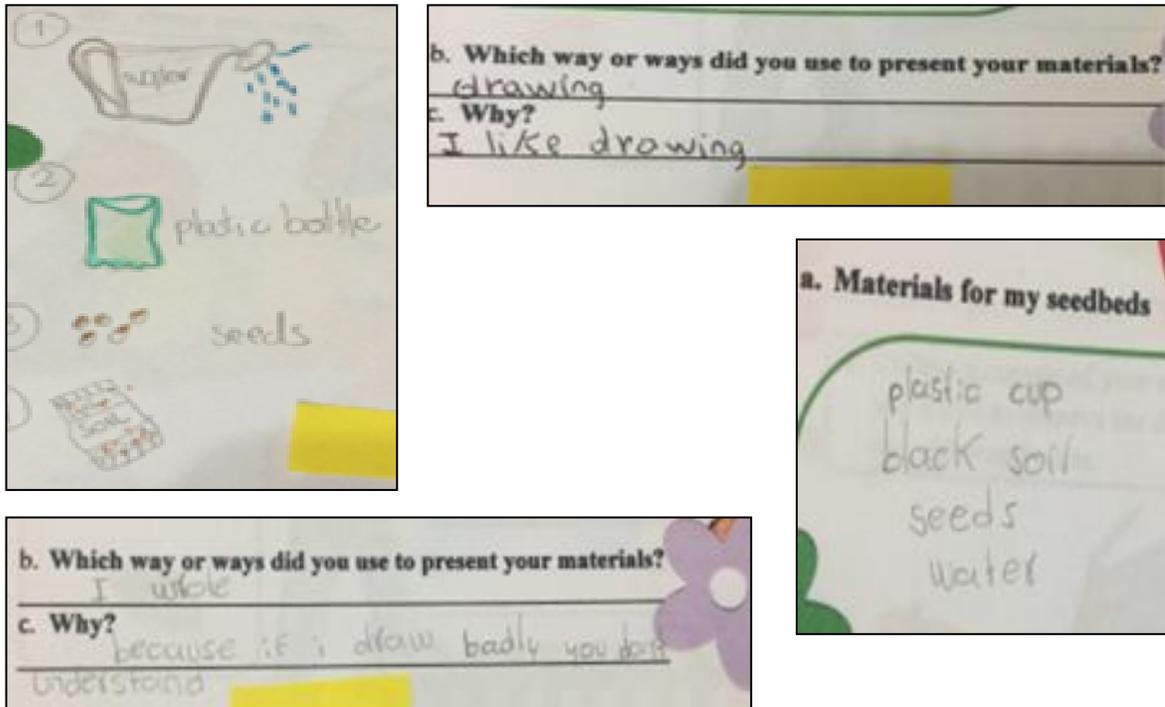
(Focus group interview)

The observations registered above demonstrate how once students are familiarize with materials they are able to make the best use out of them and the strategies proposed and are complemented with students answers in the focused group interview.

Students are used to work with texts which have images from other contexts and that at some point have relation with some topics, but the fact of having something designed for them and with colorful images they are not used to see anywhere else caused a positive impact and help them feel motivated and engaged. As mentioned by Tomlinson (2001), it is sometimes necessary “for the teacher to take the drastic step of replacing the course book altogether” (p. 1) and for the particular case of this population there was not course book oriented to their orchard project at all.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Another way for students to feel at ease with the materials was the respect towards learning styles, it also encourages students to identify the way they feel more comfortable in regards their learning process. The following excerpts are evidence of the possibility students had to select some of the ways in which they could feel better in terms of showing results as they felt they could do it.



(Students artifacts and self-assessment worksheet N°2)

I like them, they are very beautiful and I like that they have colors and designs like a real book. And we can also color if we want or just write, it is a good idea. [sic]

(Focus group interview)

Second graders are commonly told what to do and how to do it, however, as mentioned by Núñez and Téllez (2009), it is one of the SLA principles to “take into account students’ different learning styles such as visual, auditory, kinaesthetic, analytic, experiential, global, dependent, independent, etc.” (p. 176). Favoring students’ preferences to present their products is also part of their inquiry process which will be further explained in a different category.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

As part of developing materials, it is essential to consider students particularity in terms of their proficiency in the use of language and provide effective opportunities of achieving communicative purposes. As affirmed by Núñez et al. (2017), “We are cognitive beings that learn with and from others in our social contexts” (p. 25). Therefore, materials are designed in way students are not only improving on their own but also as social beings constructing knowledge also in the interaction with others. This can be observed in the following pieces of evidence:

Ss go over the materials and the strategies some of them turn the page to preview the comic that is mentioned in the instructions. Then they go back to the strategies. Before going over the comic, I read the strategy in which it is pointed out they need to pay attention to details and observe carefully before answering the questions below. After developing the activity Ss worked in small groups sharing their answers and comparing to each other’s answers. I wander around the class checking their group work and reading some of the answers. [sic]
(Field notes worksheet N° 4)

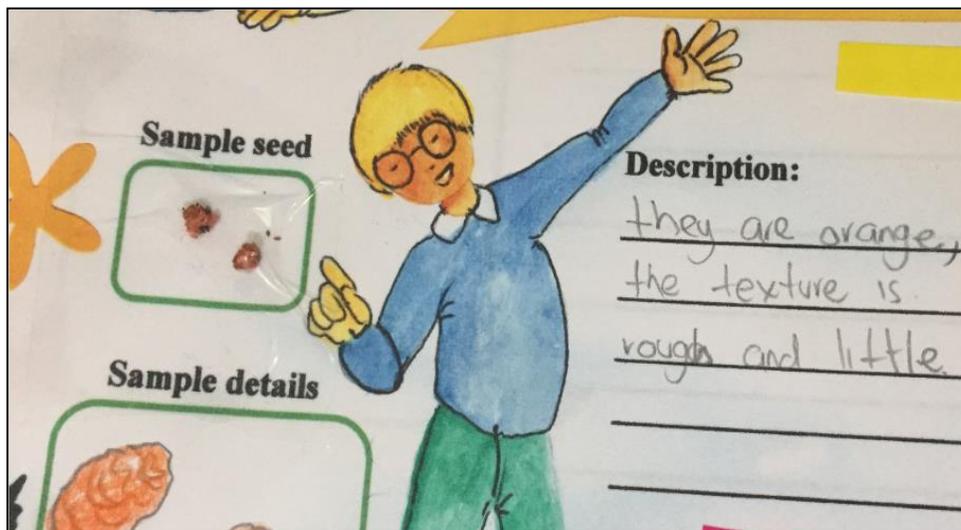
It was important to provide moments of constant interaction, students were always encouraged to use vocabulary related to science and terms they already know, but it was relevant to let them work together in pairs or small groups and allow them to interact. About materials designed by teachers Dastgoshadeh and Jalilzadeh (2011), affirmed that “the authenticity of language and language use refers to the extent to which the language used and the behaviors conducted by the learner are in line with his or her needs” (p. 86). The way in which students used the materials to communicate in the second language without being forced to do it, shows evidence of the achievement of communicative purposes.

Practicality and particularity of materials through independent practice. This subcategory refers to the needs of developing and implementing materials that can be perceived by students as relevant and useful. Which is an important part of teaching for understanding as one of the lines of action of the school where the research took place,

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

additionally it shows how students get involved easily and more effectively when they feel they are involved in significant learning.

During the implementation of the worksheets, students had plenty of opportunities to go from guided to independent practice, they could use the feedback from previous sections to achieve their goal on the Independent Inquiry stage, practicality in this case was expected as moving from the theory to the practice. As affirmed by Kumaravadivelu (2003), practicality “recognizes that no theory of practice can be fully useful and usable unless it is generated through practice” (p. 35). The following excerpts show evidence of the way students could move from the theory they learned along the science classes to the practice in which they needed to use what they knew.



(Students artifacts and self-assessment worksheet N°2)

The materials invited them to constantly make choices. The previous image shows the work of a student that selected as a tool to observe a magnifying glass as the instrument he needed to be able to describe and zoom in his seed. The field notes also provided evidence of it as it is showed as follows.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Students take more time to read the instruction, they seem to know all the vocabulary involved since there are not questions. All students select magnifying glass two students ask if there are microscopes, one of the students use one of his friends' glasses.

Students are showing practicality, they not only know the lab tools abut know how to select and use them. They are going from the theory to the practice [*sic*]

(Field notes worksheet N° 2)

In this part between point 2 and 3 SS plant their seedbeds. We check everybody has what they need, some students don't have gloves they still make part of the activity. T shows them how to prepare the soil and how to use some natural products like rice peeling and humus and mixes it with the soil they brought. They start working independently [*sic*]

(Field notes worksheet N° 2)

The field notes reflect how students know the theory behind plants needs and procedures to prepare soil and planting seedbeds.

The nature of this study promoted students to grow plants that they could later use for cooking, and, identifying use of plants. Students moved from theory from practice by being able to use their products in a way they could show their use. The following extract from one of the students' artifacts show the final product of his planting process.



Ss presented very good products, they organized their ideas following what was proposed in the worksheet. They found the ingredients they needed, wrote the sequence in a clear way. [*sic*]

(Field notes worksheet N°6)

Having the possibility of showing such products encouraged students to work independently and to identify what they did in the whole process as something relevant and useful for them.

Regarding particularity, Núñez and Téllez (2009), recalled that when designing materials teachers must take into account the particularities of the population, “A proper selection of activities must consider a range of factors such as usefulness in attaining the course purpose; suitability of students' age, interests, needs and expectations; availability of

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

use” (p. 180). This was one of the main considerations when designing the materials; on the same matter, Kumaravadivelu (2003) mentioned the relevance of considering particularity “must be sensitive to a particular group of teachers teaching a particular group of learners pursuing a particular set of goals within a particular institutional context embedded in a particular sociocultural milieu” (p. 34). Considering the socio-cultural context as well as the particularities of the school and the program was definite for the suitability and effectiveness of the design and implementation. It also guided students to be aware of their immediate context.

On the following field notes excerpt, there is evidence of this feature.

it is a workbook designed for us not like books for kids from the states and examples for them but this is about us and our school. [*sic*]

(Focus group interview)

The difference of this book and other books was that this book was designed for us, Miss Adriana told us. [*sic*]

(Focus group interview)

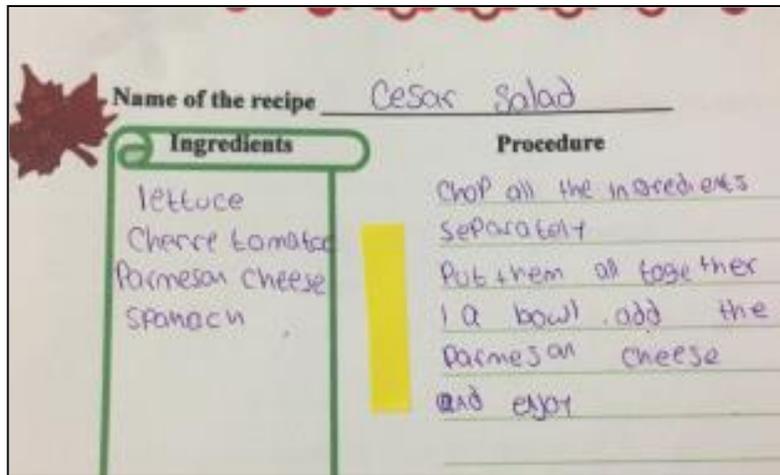
Since the beginning of this study, students could notice how the worksheets were designed for the specific purpose of developing the orchard project, which was not possible to find in their current textbook since it is a project proposed and carried out only in this grade level and based on the conditions they have at school. However, one of the purposes was to let students identify also the importance of particularity specially during the development of the independent inquiry stage. The following excerpts attain particularity evidences found in the process.

SS are writing for an audience, they respect the particularity of the materials considering they are writing for a population of their same age and general background and they will be presenting this so it needs to be accurate and well developed. [*sic*]

(Field notes worksheet N° 6)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

This could be observed specially in the last worksheets in which students needed to consider they would be read by an audience their own age in the moment of socializing their final product. The following samples show how the use of the language, procedures and even the recipes they selected were thought to a specific audience.



(Students artifacts and self-assessment worksheet N° 6)

Students were highly motivated by the fact their classmates and other people could read what they wrote and see what they had cooked, they used clear language according to the audience they expected to have access to their materials.

Students could interact with their ecosystem and determine with vivid experiences the biotic and abiotic factors from first-hand information. They also showed to be aware of their own particularity as part of their independent inquiry they could propose recipes considering the age and possibilities of future readers of their booklet.

Benefiting from PBL strategies to identify and solve problems. This category emerges from the relevance of the approach in terms of students being able to interact with their different contexts and propose from such interaction actions to improve several situations or, in other words, to lead solutions. As mentioned by Marshall (1995), “Individuals operate with and on the environment, constructing their own perceptions as

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

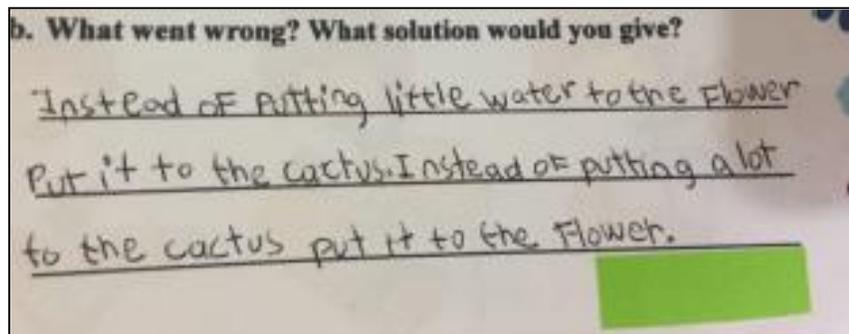
they assimilate new experiences into existing schemas and adapt the schemas to accommodate the constraints of the experiences.” (p. 15). However, there is a whole process of elaboration for getting to the point of accommodating schemas.

Another important pattern was the empowerment of students towards their projects both at home and school, and the use of strategies to overcome simple difficulties which not always achieved the expected results of product but of process and future prospective of issues that could occur in the orchard project. As stated by Othman and Ahamad (2013), “In the PBL class, when the students work with each other to solve complicated and authentic problems, they are expected to be so absorbed in the tasks that they will not only increase their content knowledge but simultaneously enhance their communicative and thinking skills” (p. 126). Although the level of complexity of the problems depended on variables such as the kind of plant or environmental conditions, students could still get involved enhancing not only communicative skills but also inquiry skills.

Identification and description of elements and situations to find needs. This subcategory is related to the initial inquiry skills that involve a deep observation of events. Nevertheless, the simple observation needs to be guided so it can go beyond and help students describe and identify the factors involved in the event, since if we do not identify the problem we cannot know what the expected outcome could be. As affirmed by Weisberg (2006), “The unsatisfactory situation is called the problem state. The situation that you want to be in—that is, the situation that you want to change the problem state into—is called the goal or goal state” (p. 123). It is essential then, to be able to produce a change having as the starting point the identification of the need.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The following extracts from the students' artifacts show the way in which students could identify a problem in a specific situation as the initial part of the process to lead a solution.



(Students artifacts worksheet N°4)

The first attempt to solve a problem is also part of the observation, it evidences the identification of factors and short descriptions of what can be identified as out of place or problematic situation. In science teaching this first observation and description of phenomena refers to the natural process of being part of the immediate environment. The following excerpts of the field notes also reflect the observations during the implementation of this worksheet.

The second question demanded students to interpret beyond what they can see and describe, they needed to identify the problem and based on what they know suggest a solution. It is also positive to see how students use their group work to cooperate and improve. [sic]

(Field notes worksheet N° 4)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The observations while students developed the worksheet and shared their answers with their classmates showed evidence of the way they could identify causes and lead solutions.

Students perceptions were also part of the data to mirror the way identifying needs helped them lead problem solving, as it is presented in the extracts below.



(Self-assessment statistics worksheet N° 4)

I can now identify problem and think on the process for example to solve them. [*sic*]
(Focus group interview)

Students perceptions support the idea expressed by Veal (1998), in reference to the nature of learning science, “Its principles include those of ‘natural’ observation and collection of raw data from the physical environment as well as those of rational hypothesis-making and induction” (p. 116). Which needs to be practiced and which involve the teacher as a facilitator of the process of discovery rather than a theoretical support with all the answers needed.

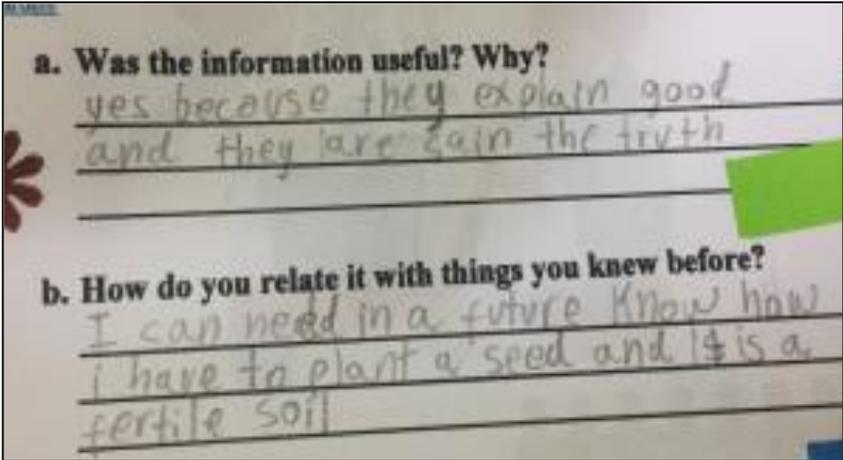
Comparison strategies lead to suitable outcomes on problems. As part of the process of problem solving, the practice of different strategies is fundamental. However, such strategies are also determined by the particularity of the population. According to the age of students and the language proficiency they were able to compare and contrast the

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

information they got and to identify what they knew, and what they needed to know to be able to determine possible outcomes.

Since our students are non-native speakers one of the concerns was the way they could move from being proficient in language used to actually use it using Science vocabulary. On this respect Veel (1998), stated that, “We can observe small children working hard to construct the category meanings of words in their mother tongue, and we become aware of the problem for ourselves when we learn a language that is culturally distant from our own” (p. 187). However, the materials guided students and pointed on strategies and instructions so they could start the process of constructing their own notions which can also be called background knowledge.

The following extracts correspond to the use of different sources of information, students read a passage and needed to build up two relations, the first in terms of appropriateness and the second of relation to the prior knowledge.



The image shows a close-up of a worksheet with two questions and handwritten answers. The first question asks if the information was useful and why, with the answer being 'yes because they explain good and they are gain the truth'. The second question asks how to relate it to prior knowledge, with the answer being 'I can need in a future know how i have to plant a seed and it is a fertile soil'. There is a green sticky note on the right side of the worksheet.

a. Was the information useful? Why?
yes because they explain good
and they are gain the truth

b. How do you relate it with things you knew before?
I can need in a future know how
i have to plant a seed and it is a
fertile soil

(Students artifacts worksheet N°3)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

a. Was the information useful? Why?
 Yes, because I didn't know exactly what to do
 my planting strategy that the other ones

b. How do you relate it with things you knew before?
 I had some knowledge about planting beans and
 I think that is a similar procedure

(Students artifacts worksheet N°3)

As presented in the artifact presented above, students were not asked with the direct question -What do you know or need to know-, but guided through the instructions and strategies. The process of the guided inquiry stage in the materials, allowed students to start identifying and relating prior knowledge and new information but leading their own process and making it part of their significant learning. This is also supported in the observations carried out and register in the teacher's field notes.

SS go over the reading passage with no difficulty in regards the vocabulary or the extension. They seem to understand and go over the questions. SS write their answers correspondently with the questions and show understanding not only in the questions but also in relating what they knew with some new information. [sic]

(Field notes worksheet 4)

On the following extract there is another example of the effectiveness of support the identification of needs based on prior knowledge.

Factor	Condition	What plants need	Possible distribution and handling solutions
Soil	wet	more of less wet	if it rains very much, I need to cover
Weather	not hot not cold	warm	what it is very cold in the morning
Temperature	18°C	warm	very hot or very cold
Any other you can remember?	insects	no insects	use salt in the rows

(Students artifacts worksheet N°1)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

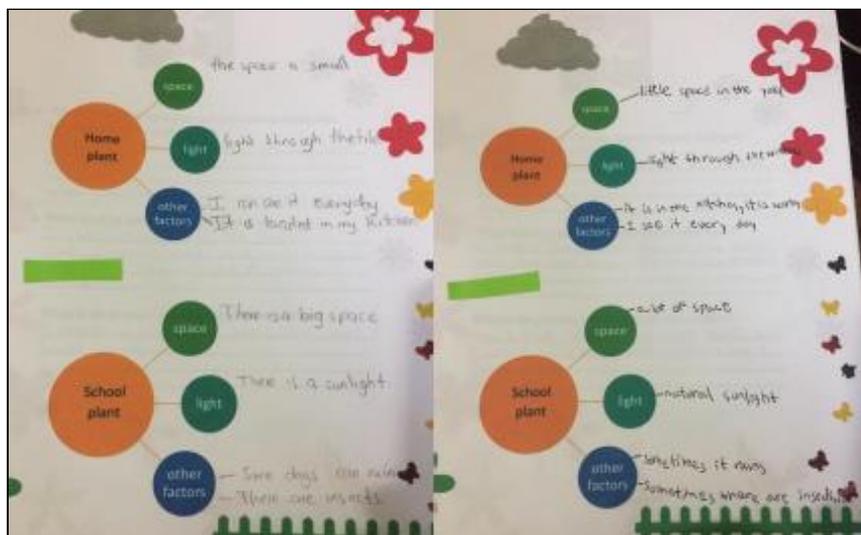
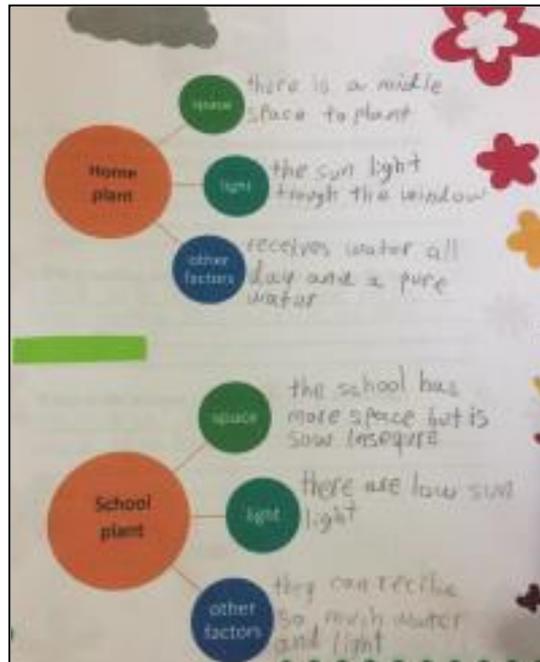
On this chart students needed to observe, describe what they observe, describe what according to their previous knowledge and finally identify what the possible difficulty could be based on the basic needs of plants. On this matter Wilson (1996), stated that, “Learners must have ownership of the learning or problem-solving process as well as ownership of the problem itself.” (p. 140). He added that “learners use information resources and instructive materials as sources of information, the materials do not teach but rather support learners’ performance” (p. 140). Empowering students by means of using what they already know as a starting point facilitates the relations and connections. The focused group interview showed students felt satisfied when they felt they could lead different kind of processes as it is presented in the following excerpt.

I love to be in charge of something and find solutions. I only need to look for the information I don’t know and use the information that I know. [sic]

(Focus group interview)

The next procedure in the process is to be able to establish relations, compare and contrast. For establishing such comparisons, Jonassen (2011), stated that “the ability of learners to solve ill-structures problems are; 1. Prior domain knowledge; 2. Prior experience in solving similar problems; 3. Cognitive skills” (p. 22), continuing with the necessary cognitive skills Genter, Loewenstein and Thompson (2003) (as cited in Jonassen, 2011) specified that “learning by drawing structural comparisons (analogical encoding) has been shown to be the most effective method for reasoning by analogy” (p. 22). On the following extracts I will present evidence of the process of compare and contrast to outcome possible solutions to simple problems.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS



(Students artifacts worksheet N°5)

Comparing through graphs helped students categorize their observations, identify needs and address the possible outcomes and solutions in both orchards, the one at home and the one at school. The field notes related to this worksheet support the evidence.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Students fill the graphic organizer appropriately they show organization and contrast between the plantings.

On the questions related to difficulties students can identify difficulties, propose solutions and think on the process to think of a solution some students mention they use what they have learnt plus their own ideas. [sic]

(Field notes worksheet N° 4)

The field notes also present observations in regard the second part of the worksheet which involved a set of questions students had to answer. It was also evident in the worksheet that students could verbalize through writing the problems they found in the process and the way they solve them as presented in the following extract.

c. What difficulties have you had in common during the process at home and at school?
 Some people didn't have care and put some much water

d. What leading solutions did you find to solve them?
 talk with my friends and with my family to take care of the plants

e. What is the process you made to get to a solution?
 think what I like to do? talk with family and friends

(Students artifacts worksheet N°5)

These extracts show how the step by step process made students feel more engaged, empowered and leading their own strategies in terms of using what they knew and needed to know, to be able to propose outcomes to possible problems during the project.

Enhancing inquiry skills. This category refers to the four skills proposed to be develop and named as OPIC (Observation, Prediction, Interpretation, Communication of results). The inquiry process is gradual and thought from the particularity of the population regarding the age and thinking development level. Bearing in mind the importance of students as the center of teaching and learning. Harste (2001), affirmed that “rather than

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

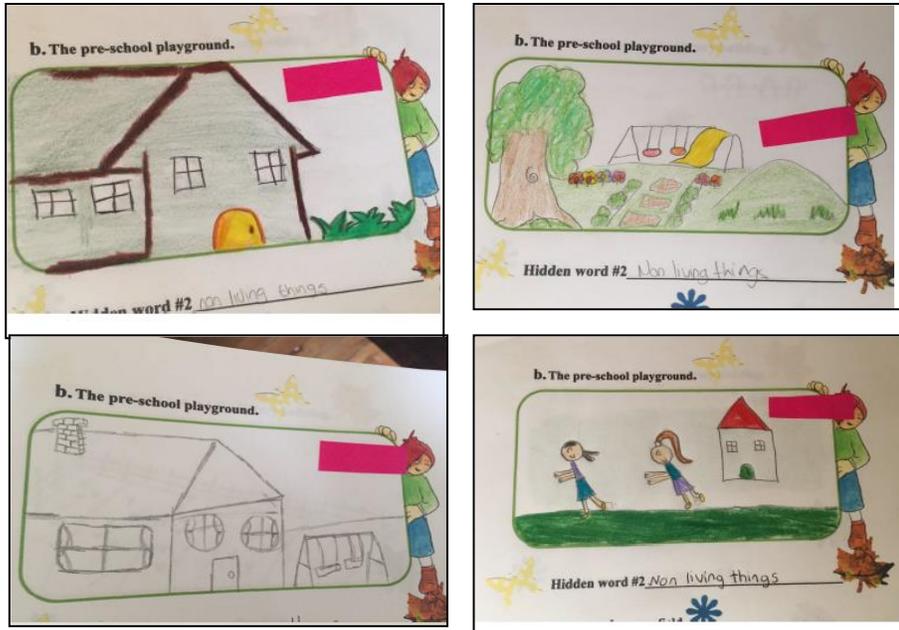
framing curriculum in terms of the content areas, learners' inquiry questions become the organizational device for curriculum. Integration occurs in the head of the learner, rather than in the daily schedule of the teacher" (p. 4). This affirmation suggest that students do not study inquiry but interiorize and integrate skills so they can make use of them alternating and producing new ways of perceiving the world.

Although the four selected skills do not necessarily happen in a specific order, based on the evidence analyzed in the data, I group them based on the way relations were presented.

Observation and prior knowledge bases for accurate prediction. Observation is usually considered the plane action of seeing things rather than the possibility of interacting with the phenomena to describe it. On this respect Harlen (2014), affirmed that "where attention to detail or to small differences is necessary it will be appropriate to extend senses by using an instrument such as a hand lens or stethoscope and to use measuring instruments to quantify observations" (p. 15). What takes us to the importance of using not only the sight and relay on it, but being able to observe with all their senses, and even to be able to use instruments that make it more accurate when necessary. It is also important to recall students need to know what is expected from them.

During the first worksheet, students were asked to register their observations on some definite places around school. However, on the observation to the school playground students showed very different products which demonstrated a mixture between reality and fantasy, incorporating elements that where not present in the place where they observed. It can be seen in the following excerpts.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS



(Students' artifacts worksheet N° 1)

The drawings made by students showed that students were incorporating their own imaginary from the places rather than actually considering the factors in each of the places they needed to observe and draw. For the specific case of Science in the Cambridge program, the observation reflected in the drawings needs to be as precise as a photograph could be. The situation was also registered in the field notes as it is presented in the following excerpt.

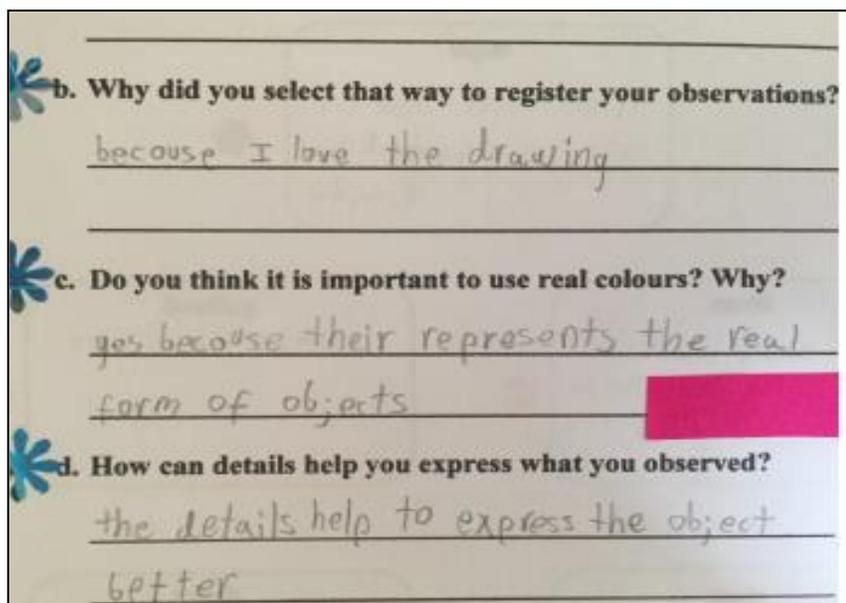
IS observation drawings are different specially in the preschool play-ground not all observed the same Some kids self-correct. Some others start getting closer and touch the leaves and the petals It is important SS follow the steps so their inquiry process develops better. [sic]

(Field notes worksheet N° 1)

Although the observations in the other areas selected showed a high level of detail during the ongoing feedback students were encouraged to use only real information for making more accurate registers.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

The second part of this worksheet permitted students to reflect upon their first task and was a reminder of the importance of accuracy in graph in the area of science as it is presented in the following excerpt.



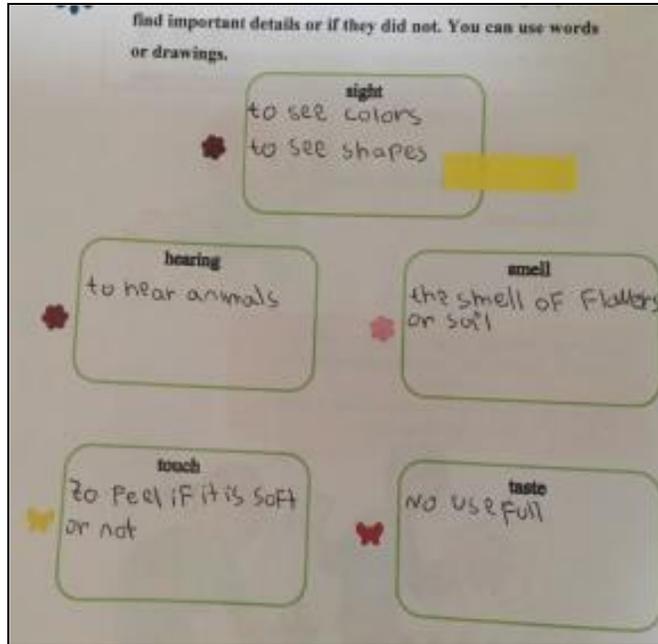
The image shows a worksheet with three questions, each marked with a blue star icon. The questions and their handwritten answers are as follows:

- b. Why did you select that way to register your observations?**
because I love the drawing
- c. Do you think it is important to use real colours? Why?**
yes because their represents the real form of objects
- d. How can details help you express what you observed?**
the details help to express the object better

(Students' artifacts worksheet N° 1)

Materials facilitated students to move from a basic observation level to a more accurate one through the exploratory and guided practice, students could identify factors that are present in the observation process and that go beyond the use of the sight so they can incorporate and be aware of the use of their senses in the process. On the following extract there is a sample of what students could describe about the use of their senses in the observation process.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS



(Students' artifacts worksheet N° 1)

The observation skills guided by the use of all senses to perceive details provided students with tools to become accurate observers. This is also perceived by students according to the focus group interviews an excerpt from it is presented below.

we can observe with all our senses but we have to be careful with touching or smelling some things [sic]

(Focus group interview)

After the pair and teacher feedback, students process flowed easily. They started using other strategies for observing and recognizing the importance of using all their senses to get better details, they also started using different ways for describing what they observed.

The importance of detailed observation and description of the phenomena observed was referred by Ash (1999), "Observation provides the evidence that allows ideas to be checked, and it therefore needs to be detailed and relevant. The learner must have confidence that her observations are valuable" (p. 55). Once students feel confident about

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

their observation they can make accurate description and eventually assertive prediction based on the observation.

Based on observations students tried to set accurate predictions. Students involved in this research had clear the importance and the difference between guessing and predicting, however it was reminded in the science strategies of the worksheets that aimed this goal. In Peters and Gega's insight (2005), "Without some data, we can only guess about future observations; to predict is impossible. When students put their data in graph form, they usually have many chances to predict" (p. 98). The necessary data for students to predict came as product of their observations and measures and in other cases data given by the worksheets as it is presented in the following extracts.



(Students' artifacts worksheet N° 4)

This particular set of data refers to graphs students built by students measuring their plants every week, the blue line corresponds to the prediction and the green line corresponds to the real measure. The data as well as the predictions were susceptible to

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

change every week since they depended on the plant current growth and conditions. This is supported by the field notes as it is presented on the following excerpt.

The graphs are well developed, they need to observe and register information, they did it. They also need to predict and graph their prediction they did it between the limits of reliability. The real growth line shows communicating results. Observing the results, they can make an accurate prediction which would be represented in the blue line. [sic]

(Field notes worksheet N°4)

As it is described in the field notes, students needed to observe and measure so the predictions were connected to this specific set of data. It is important to recall that the graph is just one type of data they can observe. Data can also come from pictures, sets of images or as in this case the direct contact with the seedbeds and seedlings they had planted.

After the process of observing, making the graph and adjusting the prediction based on it, students needed to reflect about the process and analyze the outcome of their predictions, learning from the accuracy or inaccuracy of their graphs and explain the reasons. The following extract from students' artifacts show evidence of it.

a. Describe your prediction in relation with the real line.
(hint: just describe, say how accurate it was, how similar, how different.)

At home my plant grew less than what I thought and at school it grew a little more, it was not so far from reality but was not exact.

b. Why was your prediction accurate or not so accurate?
(hint: check if you considered or missed any of the factors and variables.)

I think it was a little accurate because I know plants take some time to grow so I was realistic.

c. What prediction would you make based on the graph and the information you have so far?
(hint: remember predictions are not guessing.)

I think my plants will grow differently they need to grow long leaves but grow differently they need to

(Students' artifacts worksheet N° 5)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Students' answers reflected they understood the importance of making predictions based on good foundations, on the last answer they can predict now not by graphing but by writing based on the last data they collected from their observation and considering the previous ones.

During the focus group interviews when students were asked about what they had learnt in regard predictions, they related this skill with the observation process as it is presented below.

- To make a prediction I have to observe and not only think or guess with my opinion
 - That we can anticipate what will happen in the next step. [*sic*]
- (Focus group interview)*

As it was proposed by the materials, students not only predicted based on observations and prior knowledge, they could also graph their predictions and after five some weeks go over and validate the accuracy of their predictions. The same graphs they produced from the direct observation of seedbeds and seedlings was used as the data to predict and graph suitable outcomes.

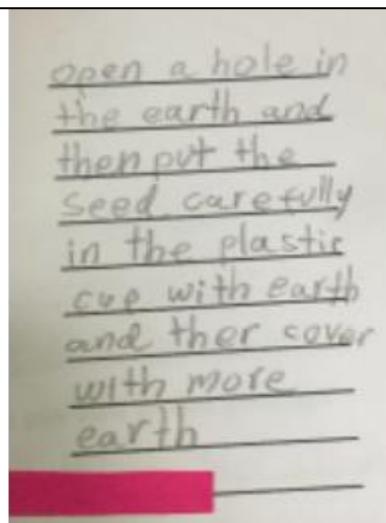
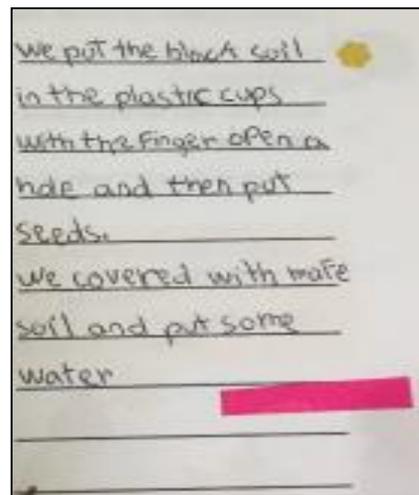
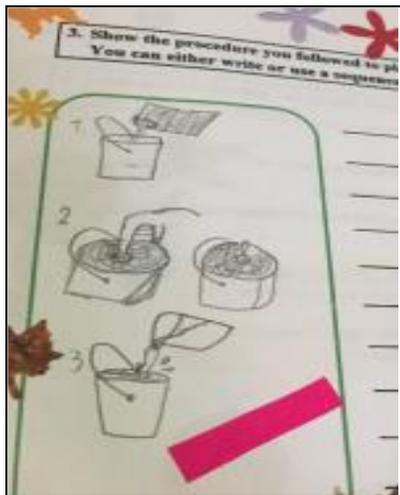
Appropriate interpretation of data supports different ways of communicating results. The last subcategory emerges from the pattern found with the inquiry skills Interpretation of results and Communication of results. As mentioned before skills do not follow a fixed order, students can move from one to the other according to the task or the need. Students interpret a model or sample of different ways of communicating their results. As defined by Peters and Gega (2005):

Communication is putting the information or data obtained from our observations into some form that another person can understand or some form that we can understand at a later date. Children learn to communicate in many ways. They learn to draw accurate pictures, diagrams, and maps; make proper charts and graphs;

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

construct accurate models and exhibits; and use clear language when describing objects or events. (p. 94)

From the ways of communication, the above-mentioned authors reoffered we can also imply students can interpret also what others communicate, and in the interaction, they realize some other ways to present the same kind of data. On the following extracts of students' artifacts, I will present the way in which students decided to communicate descriptions, sequences, comparisons among other tasks required in the materials.



(Students' artifacts worksheet N°2)

On the extracts presented above, students needed to communicate the first stages of the planting process. Students showed appropriate sequences in both ways of presenting by

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

writing and by drawing. Considering the age of students, when they draw to communicate either observations or findings they took longer time than when they needed to write.

However, the results showed they felt more engaged when they could select in which they wanted to present their findings. The following excerpt from the focus group interview show the perception of one of the students regarding the way they communicated what they interpreted.

it is important to make predictions and to find answers. I prefer writing sentences. It is important to interpret but data is not only graphs, data can be many things and I can learn new things or get new information. [*sic*]
(*Focus group interview*)

The way in which students communicated their processes varies from one student to the other, they had clear what they preferred to develop each of the activities and some others used varied ways to do it.

Comparing the way others communicate findings is also a way of enriching their own form of communicating. As stated by Ash (1999), “Communication in the inquiry classroom goes beyond simply exchanging knowledge. It implies that socially gathered and shared information informs individual learning” (p. 60). During the orchard project, the level of difficulty varied. After students planted at home they needed to start interpreting what was happening in both places, comparing and contrasting both processes and presenting their findings to the class. On this regard, students were asked to select a graph to communicate both processes and after that they had the chance to compare the way they communicated results. On the following extracts I will present some samples of the graphs students decided were their best option to communicate results in both, at home and at school.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

My graphic organizer is Spider's chart

Share your guide with your classmates to identify the way they did.

Was it similar or different from yours? Why?

similar because the differences we minimal

My graphic organizer is Venn diagram

Share your guide with your classmates to identify the way they did.

Was it similar or different from yours? Why?

similar because you use the same materials and different in the shape

My graphic organizer is comparative chart

Home	School
<ul style="list-style-type: none"> • It is in a big bottle • the temperature is usually warm • it is next to a window 	<ul style="list-style-type: none"> • it is in a small cup • the temperature is very cold at night • it is next to a window

Share your guide with your classmates to identify the way they did.

Was it similar or different from yours? Why?

similar because all have the similar ideas

My graphic organizer is spider chart

Share your guide with your classmates to identify the way they did.

Was it similar or different from yours? Why?

different because you use different materials

(Students' artifacts worksheet N°3)

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS



(Self-assessment statistics worksheet N°3)

The four different graphs selected by students show the way in which they can communicate what they interpret from their observations. Likewise, the self-assessment showed that all students felt they had different ways to register their findings.

The field notes from this worksheet reflect not only the process students followed to communicate their findings but also the opportunities of interactions they had with their classmates as it is presented below.

Ss selected the graphic organizer they wanted to use. They used; spider charts, Venn diagrams, comparative charts. When they compared the graphic organizers with those from their friends they find that even when the organizer might vary the information they have is similar. [*sic*]
(Field notes worksheet N°3)

Graphic organizers were already a tool to compare and contrast. Additionally, having the chance to share and compare to each other let them identify elements in common not only in the graphs per se but also in the planting process, interpreting their classmates' graphs and the information they got during the interaction which encouraged them to communicate their results also in an oral way.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Students also looked for other sources of information and made connections from the plants and their uses, as shown in the extracts below they could



(Students' artifacts worksheet N°5)

The use of different resources, as shown in the previous images, to communicate findings is also supported by the results of the focus group interviews as shown in the following excerpt.

Sometimes I prefer drawing but sometimes I prefer writing if I don't have time for example. I also liked we can make pictures and that is another form. [sic]

(Focus group interview)

Interpreting data and communicating results is a process that according to the age of the population is not limited to the description of what they see in a graph, they can interpret their observations, the phenomena around them, their classmates products and through the materials they found the opportunity to present data going from drawings and

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

short sequences to comparative mental maps, identifying similarities and differences among their way to present in comparison with others and use of resources to present findings.

The categories and subcategories supported I have already described allowed me to get to significant conclusions which will be explained in the next chapter.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Chapter V

Conclusions and Pedagogical Implications

This chapter contains the main conclusions of this research study, which emerged from the analysis of the data gathered with three instruments; students' artifacts, field notes and focused group interview. The purpose of this analysis was to see the contribution of implementing teacher designed materials focused on a problem-based learning approach to improve inquiry skills in second graders at a private school. Moreover, it describes the pedagogical implications for the participants including not only students but also me as a teacher researcher and a materials developer; and the institution where it was carried out. Lastly, it will present the constraints and prospective for future related studies.

Conclusions

In relation to the research question, it is concluded that the implementation of teacher designed materials promotes self-construction of knowledge moving from the theory to the practice by finding what is being learnt useful and relevant, this usefulness is what Kumaravadivelu (2003) names the practicality micro strategy. On the same matter, scholars such as Núñez et al. (2004), Núñez and Téllez (2009), Shaw and Masuhara (2012), Tomlinson (2011), supported that materials designed under the guidance of principles and theoretical background achieve and affective and effective impact on students. Additionally, understanding the socio-cultural context of the population and the place where the research took place, which is the particularity micro strategy coined by Kumaravadivelu (2003), allowed students to be an active part of their learning process and to feel empowered about their improvement and needs.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

It is also worth mentioning that materials that are sequenced and provide students with strategies to achieve communicative goals and independent practice had a highly positive impact in students' self-investment.

Moreover, it can be said that problem-based learning strategies benefit identification and description of elements and situations to find needs, and as mentioned by Boud and Feletti (1997), promote opportunities for interaction and learning by doing or experiencing. In regard to intrinsic motivation for learning students were constantly engaged, involved and satisfied with the levels of responsibility and discovery that a project like the orchard might provide. As mentioned by Schmidt (2012), it allows students to have a deeper comprehension of reality and also self-discovery of their own abilities, which for this particular case were oriented in the leadership as one of the pillars of character promoted by school philosophy.

Regarding the development of specific inquiry skills (Observation, Prediction, Interpretation, Communication) it can be concluded that they are enhanced in a process that goes from exploration stage to guided stage, and finally end up in independent practices. All practices are based on constant teacher monitoring that conducted students to go through observation and prior knowledge for accurate prediction and appropriate interpretation of data that supports different ways of communicating results. As referred by Kuhlthau, Maniotes and Caspari (2007), being able to go from observation to prediction is already showing a deep way of understanding, and the close relation between these skills is ratified by Ash (1999) who outlined that the interpretation and communication of findings are logical consequences of the development of the Observation and Prediction skills. The students who were part of this study showed improvement in the quality of their interpretations and predictions, demonstrated they could communicate results in simple and

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

more complex ways depending on the requirement and they could interpret different types of data from various sources.

The results of the data analysis showed that students were motivated with materials designed for them and their specific needs. It also showed students committed to their learning process and ready to face the challenges of their science project at home based on the evidences they presented in pictures, assignments and final products of the plants they grew as well as the school orchard. These students proved to be able to overcome the situations by preventing them based on their observations and predictions, and that way being ready to solve problems based on what they already knew and being able to look for what they needed to know. The reflective processes and the varied way of carrying out the development of the worksheets showed a level of independence and leadership. It is also satisfactory the fact that students refer to the possibilities they had to apply the strategies they have learnt to lead processes like the home planting in which they did not have constant supervision or support from the teacher.

Pedagogical Implications

This research study had implications in different areas. The most important one refers to the impact on students, who are used to working on texts and topics related to the curriculum, but who were not expecting a text that is designed exclusively for them and thinking on their interests and appeal and designed to fulfill a specific objective with their orchard project. As Núñez et al. (2017) affirmed “teacher-developed materials fit into the category of contextualized materials that are context-bound since they are responsive to local needs” (p. 34). These contextualized materials enhanced motivation, self- assessment and constant motivation. It also implied recognizing as mentioned by Montijano (2014), “Teachers can counterbalance or offset any deficiencies of the textbook” (p. 14). And even

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

though students already handled a Science textbook it did not provide opportunities for the particularities of the population.

The second implication deals with the school where the research took place. Being a school oriented by the Teaching for Understanding model, it is supposed to focus the development of the programs on significant learning and inquiry skills. However, once the materials and results were socialized in the Environmental Sciences Department, the general appreciation was that these kind of materials, even though they are demanding in time and effort, constitute a unique opportunity for the development of projects that are not contemplated in the standardized textbooks. From these appreciations, I can infer that the work I have done can contribute and inspire other teachers to do so for their grade level and particular projects of their students.

Finally, as a teacher researcher and material developer, this research study had me reflect on the responsibility of being aware of my students' needs. It has contributed to my self- assessment in terms of evaluating what I can do as a teacher and the impact of my choices in terms of materials and methods on my students. As stated by Núñez et al. (2004), "Teacher as innovative professionals, have the potential to explore their creativity by designing materials for their classes" (p. 130). I realized about the need of being updated and develop all my creativity, potential and theoretical background to produce significant changes in my way of teaching. Going beyond this point, Kumaravadivelu (2013), pointed out the needs of materials that produce a social impact and that take students to know the culture and social aspects of their immediate context. As educators and role model for the generation of students we are teaching, it is also part of our responsibility to accompany and facilitate their learning with ways to re-discover their world and re-discover themselves as useful and proactive members of their community. As materials developers our creativity

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

must be guided by principles and theoretical frameworks that aimed to take the best out of our students' potential, through the development of contextualized materials.

Limitations

One of the main limitations was the numerous activities programmed by the institution which overlapped with the initial chronogram. Especially considering, that some of the worksheets implied direct interaction with the plants that were growing in the orchard and could not be postponed. Nevertheless, the commitment of students and their hard work even during recess times to complete some of the tasks helped us overcome this situation.

Another limitation was the absence of some participants on dates close to summer or spring breaks, who had to develop the worksheets on different moments, and it implied double work in terms of feedback correction and guidance. It also implied that some of the written part students made at home were not always complete.

Questions for Further Research.

Considering the process and the findings mentioned above, there could be an integration in terms of the skills that can be integrated in other areas of knowledge. Two questions proposed for further investigation might be: What does the implementation of teacher-designed materials on a PBL approach reveals about comprehension in areas such as Mathematic or Language arts? How can the development of inquiry skills integrated to other areas of the curriculum as mathematics show about students' processes of critical thinking?

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

References

- Arhar, J.M, Holly, M.L, & Kasten, W.C. (2001). Elements of design: Planning and documenting the action. *Action Research for Teachers*, 11, 131-166.
- Ash, D. (1999). The process skills of inquiry. In *Foundations A monograph for professionals in science, mathematics, and technology education*. 2, (pp 51-62).
- Berardo, S. A. (2006). The use of authentic materials in the teaching of reading. *The Reading Matrix*, 6(2), 60-69. Retrieved from:
<http://www.readingmatrix.com/articles/berardo/article.pdf>
- Bitsch, V. (2015). Qualitative research: A grounded theory example and evaluation criteria. In *Journal of Agribusiness. Agricultural Economics Association of Georgia*, p.10
- Blythe, T. & Associates (1998). *Teaching for understanding guide*. Jossey- Bass Inc Publishers, Harvard.
- Boud, D., & Feletti, G. (1997). *The challenge of problem-based learning*. London:Kogan
- Burns, A. (1999). *Collaborative action research for English language teachers*.
Edinburgh: Cambridge University Press.
- Charmaz, K. and Henwood, K.L. (2008). Grounded theory. In: Willig, C. & Stainton-Rogers, W. (eds.). *Handbook of qualitative research in psychology*. pp. 240-260. London: Sage
- Corbin, J. & Strauss, A. (2015), Basic of qualitative research: *Techniques and procedures for developing grounded theory* (4th ed.). Thousand Oaks, CA: Sage
- Cresswell, J. (2012). *Qualitative inquiry and research design*. Thousand Oaks, CA: Sage.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Dastgoshadeh, A., Jalilzadeh, K. (2011). European Journal of Scientific Research. EuroJournals Publishing,84-87 Retrieved from <http://www.eurojournals.com/ejsr.htm>
- Denzin, N. (1989). *Interpretive interactionism*. Newbury Park, CA: Sage
- Elliot, J. (1991). *Action research for educational change*. Philadelphia; Open University Press.
- Freeman, D. (1998). *Doing teacher-research: From inquiry to understanding*. Heinle and Heinle Publishers.
- Gilmore (2007). Authentic materials and authenticity in foreign language learning. *Language Teaching*, 40, 97-118.
- Glen O'Grady, Elaine Yew, Karen P.L. Goh, Henk Schmidt. (2012) *One-day, one-problem: An approach to problem-based learning*. SpringerLink: Bücher. Springer Science & Business Media
- Gómez, L. F. (2010). English textbooks for teaching and learning English as a foreign language: Do they really help to develop communicative competence? *Educación y Educadores*. 13(3), 327-346.
- Gomez, L. F. (2015). En The cultural content in EFL textbooks and wath teachers need to do ababout it. *PROFILE Issues in teachers "Professional Development*, 17(2)167-187). Retrieved from: <http://dx.doi.org/10.15446/profile.v17n2.44272>
- González, A. (2006). On materials use training in EFL teacher education: Some reflections. *PROFILE Issues in Teachers Profesional development*, 7, 101-115.
- Graves, K. (1997). *Teachers as course developers*. Cambridge: Cambridge University Press.
- Graves, K. (2000). *Designing language courses: A Guide for Teachers*. Boston: Heinle & Heinli Publishers.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Gray, J. (2010). *The branding of the new capitalism: Representations of the world*
 Boston: Heinle & Heinli Publishers
- Hargreaves, D. & Hopkins, D. (1994). *The empowered school: The management and
 practice of development planning*, London: Cassell
- Hammersley, M. & Atkinson, P. (1983). *Ethnography: Principles in practice*. London:
 Routledge.
- Harlen, W & Jelly S. (1997). *Developing science in the primary classroom*, Longman.
 Liverpool.
- Harste, J. (2001). *What Education as Inquiry Is and Isn't I*. Indiana University. Sibel
 Boran and Barbara Comber editors chapter one.
- Huessien, A. A., (2012) Difficulties faced by Iraqi teachers of English in using authentic
 materials in the foreign language classrooms. *Al- Fatih Journal*. 50. Retrieved
 from: <http://www.iasj.net/iasj?func=fulltext&aId=61274>
- Herrera, L. & González, M. (2015). Developing the oral skill in online English courses
 framed by the community of inquiry. *PROFILE Issues in Teachers Profesional
 development*, 19, 73-88
- Hidalgo Dávila, H., & Caicedo Vela, M. (December de 2011). *A case study on content
 based instruction for primary school children*. *HOW(18)*, 112-134. Bogotá,
 Colombia.
- Howard, J., & Major, J. (2004, October). *Guidelines for designing effective English
 language teaching materials*. Paper presented at Ninth Conference of the Pan-
 Pacific Association of Applied Linguistics, 101–109. Seoul, South Korea
- Huessien, A. A., (2012) Difficulties faced by Iraqi teachers of English in using authentic

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- materials in the foreign language classrooms. *Al- Fatih Journal*. 50. Retrieved from:
<http://www.iasj.net/iasj?func=fulltext&aId=61274>
- Jolly, D. and Bolitho, R. (1998) A framework for materials writing. In: Tomlinson, B. (Ed.), *Materials Development in Language Teaching*. (pp. 90-115) Cambridge: Cambridge University Press.
- Jonassen, D. (2011). *Learning to solve problems: A handbook for designin problem-solving*. New York: Routledge.
- Kuhlthau, C., Maniotes, L., & Caspari, A. (2007). *Guided inquiry, learning in the 21st century*. London: Libraries unlimited.
- Kumaravadivelu, B. (2003). *Beyond methods: macro strategies for language teaching*. New Haven; USA: Yale University Press.
- Kumaravadivelu, B. (2014), The decolonial option in English teaching. *TESOL QUARTERLY*
- Lankshear, C., & Knobel, M. (2006). *Teacher research from design to implementation*, New York, NY: U.S.A. (Original work published 2004).
- Lichtman, M. (2013). *Qualitative research for the Social Sciences*. Virginia: SAGE Publications.
- Manual de Convivencia Gimnasio Colobo Británico Bogotá (2016).
- Markee, N. (2001). *The diffusion of innovation in language teaching*. London: In Hall, R & Hewings.
- Marmolejo, F., & Cevasco, J. (2014). Text comprehension as a problem solving situation. *Universitas Psychologica*, 725-743.
- Marshall, S. (1995). *Schemas in Problem Solving*. Cambridge University Press.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Marshall, C., & Rossman G. (1999). *Designing Qualitative Research 3rd Edition*. Virginia: SAGE Publications.

Martin, J.R. & Veel, R. (1998). *Reading science critical and functional perspectives on discourses of*. Routledge New Fetter Lane, London.

Masuhara, H. (2004). Materials adaptation. In Tomlinson, B. & Masuhara, H., *Developing language course material*. RELC Portfolio Series 11(pp. 1-7). Singapore: RELC

Mendieta, A. J. (2009). Inquiry as an opportunity to make things differently in the classroom. 124-135. Bogotá, Colombia.

Mertler, C. (2009). *Action research: Teachers as researchers in the classroom*. (2nd ed.). The United States of American, SAGE Publications, Inc.

Ministerio de Educación Nacional, M (1998). Serie Lineamientos Curriculares Ciencias Naturales y Educación Ambiental. Bogotá, Colombia.

Ministerio de Educación Nacional, M. (2002). Serie Lineamientos curriculares . Bogotá, Colombia.

Montijano, M. (2014) Textbook use training in EFL teacher education. *Utrecht Studies in Language & Communication*, 27, 267-285)

Núñez, A. (2010). The teaching of English within the theory-practice alternance model. In: *Innovación y Competitividad Jornada de Investigación 2010*. Dirección de Investigaciones y Estudios Empresariales Fundación Universitaria Empresarial de la Cámara de Comercio de Bogotá Uniempresarial.

Núñez, A., & Pineda, C. (2001). *Getting in touch with reality: An English curriculum to boost students' critical thinking skills and interest in global issues*. In *HOW, A Colombian Journal for Teachers of English*, 9, 34-39.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Núñez, A., Pineda, C., Téllez, M. (2004). Key aspects for developing your instructional materials. *PROFILE Issues in Teachers' Professional Development*, 5, 128-139. Bogotá: Universidad Nacional de Colombia.
- Núñez, A., & Téllez, M. (2008). Meeting students' needs. *Enletawa Journal*, 1, 65-68. Tunja: Universidad Pedagógica y Tecnológica de Colombia.
- Núñez, A., & Téllez, M. F. (2009). ELT materials: the key to fostering effective teaching and learning settings. *PROFILE: Issues in Teachers' Professional Development*, 11(2), 171-186.
- Núñez, A., & Téllez, M. F. (2012). *Using debates in the classroom: A pedagogical strategy for the development of the argumentative competence in the teaching of English as a foreign language*. Bogotá: Departamento de Publicaciones Universidad Externado de Colombia.
- Núñez, A., & Téllez, M. F. (2015). Reflection on teachers' personal and professional growth through a materials development seminar. *HOW, A Colombian Journal for Teachers of English*, 22(2), 57-74.
- Núñez, A., Ramos, B., & Téllez, M. (2006). *Reflexión en el contexto educativo: Hacia la toma de decisiones en el aula*. *Revista de Contaduría Pública @puntos Cont@bles* 11, pp. 111-115. Bogotá: Publicaciones Universidad Externado de Colombia. ISSN 1657-7175.
- Núñez, A., Téllez, M. F., & Castellanos, J. (2012). A framework for materials development: A path for in-service teachers to build up the instructional design of their research studies. In Núñez, A., Téllez, M. F. & J. Castellanos (Eds.), *Teacher research on English didactics issues* (pp. 17-37). Bogotá: Departamento de Publicaciones Universidad Externado de Colombia.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Núñez, A., Téllez, M. F., & Castellanos, J. (2013). Document: Proposal for the research line materials development and didactics (Ascribed to the Research Group:

Critical Pedagogy and Didactics for Social Transformation). Universidad Externado de Colombia.

Núñez, A., Téllez, M. F., & Castellanos, J. (2017). *Materials for the Learning of English and teachers' professional growth*. Universidad Externado de Colombia

Núñez, A., Téllez, M. F., & Castellanos, J. (2017). *The Role of Teacher developed materials in fostering English Language Skills*. Universidad Externado de Colombia

Núñez A., Téllez M., Castellanos J. and Ramos B. (2009). *A practical material development guide for EFL pre-service, novice, and in-service teachers*. Bogotá: Departamento de Publicaciones Universidad Externado de Colombia.

Othman, N. & Ahamad, M. (2013). Problem-Based Learning in the English Language Classroom. In *English Language Teaching*; Vol. 6, No. 3. Canadian Center of Science and Education.

Parada Moreno, C. J. (2008). *Learning English through inquiry: An acquired experience in three public settings in Colombia*. (Unpublished masters' thesis) 141-166. Bogotá, Colombia.

Peters, J., & Gega, P. (2005). Developing inquiry skills. En *Science in elementary education* (págs. 80-108). New Jersey: Prentice Hall.

Pineda, C., Núñez, A., & Téllez, M. F. (2004) *Unidades Didácticas Relacionadas con Pensamiento Crítico: Una Alternativa para Fomentar la Competencia Lingüística en Lengua Extranjera*. Revista de Contaduría Pública @puntos Cont@bles N°5, pp. 65-78. Bogotá: Publicaciones Universidad Externado de Colombia.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Pineda, C. (2001). Developing an English as a foreign language curriculum: The need for an articulated framework. *Colombian Applied Linguistics Journal*, 3(1), 6-20.
- Potter, J. (1996) *An Analysis of Thinking and Research about Qualitative Methods*. Psychology Press Publishers. California
- Ramos, B., & Aguirre, J. (2014). Materials development in the Colombian context: Some considerations about its benefits and challenges. *HOW, A Colombian Journal for Teachers of English*, 21(2), 134-150.
- Richards, J. C. (2006). Materials Development and Research-Making the Connection. *RELC Journal*, 5-26
- Rico, C. (2005). The Matter of Selecting and Evaluating Materials. *MATSDA Folios*.
- Rico, C. (2005). The Matter of Selecting and Evaluating Materials. *MATSDA Folios*.
- Rico, C. (2012). Language teaching materials as mediators for ICC development: a challenge for materials developers. *Signo y Pensamiento*, 30, 130- 154 .
- Sandoval, V. (2015). *Evaluación del impacto del programa pequeños científicos en el Colegio Fanny Mikey Jornada Mañana*. (Unpublished masters' thesis) Universidad Externado de Colombia. Bogotá, Colombia.
- Schmidt, H. (2012). *One –day, one-problem. An approach to problem-based Learning*. Springer Ed: Singapore
- Science Scheme of Work, Stage three. (2015) London: Cambridge University Press.
- Standford University Newsletter on Teaching. (2001). Problem-based learning. In *Speaking of Teaching*, 1-8.
- Stepien, W., & Gallagher, S. (2001). Problem-based learning: As authentic as it gets. *Educational Leadership*, 50.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- Stevens, J. 1996. *Applied multivariate statistics for the social sciences*. 3rd ed. Mahwah, NJ: Lawrence Erlbaum Associates.
- Stottok, B., Bergaus, M. & Gorra, A. (2011). *Color coding: an alternative to analyze. Empirical data via grounded theory. Research Methods*. Retrieved from <http://connection.ebscohost.com/c/articles/62796110/colour-coding-alternative-analyze-empirical-data-via-grounded-theory>
- Swaffar, J. K. 1985. Reading authentic texts in a foreign language: A cognitive model. *The Modern Language Journal* 69 (1), 15–34.
- Tomlinson, B. (1998). *Materials development in language teaching*. London: Cambridge University Press.
- Tomlinson, B. (2003). *Developing materials for language teaching*. London: Cambridge University Press.
- Tomlinson, B., (1999). *Materials development in language teaching*. United Kingdom: @ Cambridge U Press. (Original work publisher 1998).
- Tomlinson, B. (2011). *Materials development in language teaching*. London: Cambridge University Press.
- Tomlinson, B. & Masuhara, H. (2010). *Research on materials development for language learning. (Eds.) Research for materials development in language learning, evidence for best practice. (2-18)*. New York: Continuum International Publishing Group.
- Tudor, I. (2001). *The Dynamics of the language classroom*. Cambridge University Press.
- Weisberg, R. (2006) *Creativity understanding innovation in problem solving, Science, Invention, and the Arts* John Wiley & Sons, Inc

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Wiling, C. (2013). *Introducing qualitative research in psychology*, 3/e. chapter 7. UK McGraw Hill education

Wilson, B. (1996) *Constructivist learning environments: Case Studies in Instructional Design*. Harvard university.

Wynne, H. (2014). Inquiry in primary science education (IPSE) 1(5), 5-19 PRI-SCI-NET editions.

Yu, L. (2015). *Problem-based learning materials design: Medical English Course*. 5(7), pp. 1346-1351.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Appendix A

Needs Analysis Survey

GCB

Science second grade

Survey

Dear students, as you already know I am currently studying a master's program. The objective of this study is to develop materials to improve the use of your inquiry skills.

As part of my research study it is very important for me to know what you think about some aspects. All your answers will be used only for research purposes and will be confidential.

Please answer the following survey being totally honest with your answers and following instructions. It does not have a grade and there are no wrong answers.

Answer the following questions using a black pencil. If you have any doubt, ask your teacher before answering.

1. In the following chart, rate from 1 to 5 (1 for the least favorite and 5 for the most favorite) the materials used in class

Materials	1	2	3	4	5
Text book					
Laboratory guides					
Orchard worksheets					

2. From the homework your science teacher assigns, which one do you prefer? (Mark one option)
- reading
 - home observations
 - writing
3. Read the following sentences and write on the line **A** if you agree or **D** if you disagree
- The materials make you feel comfortable _____
 - The materials have images related to the topics _____
 - The vocabulary used is easy to understand _____
 - The materials complement what I find in the book _____
 - I can develop the activities by myself _____
 - There is a variety of activities for different ways of learning _____

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

- g. The teacher gives you feedback from the activities _____
4. How do you prefer to express your ideas in Science class?
- writing them
 - speaking in class
 - drawing
5. Do you consider explaining in English your ideas is:
- very easy
 - easy
 - difficult
 - very difficult
6. Which of the abilities from Science do you consider you are good at. You can choose more than one option.
- observation
 - prediction
 - interpretation
 - communication
7. Select the sentence or sentences that better describe what you think.
- I can use what I learn in this class in other subjects.
 - I can use what I learn in this class at home.
 - I can only use what I learn in this class for science.
8. From the following list, select what you use to solve a problem. You can choose more than one option.
- observe what happen
 - read about the topic
 - ask my teacher
 - make an experiment or a trial
9. Do you think you can solve situations at home by making observation, prediction, interpretation and communication?
- very likely
 - likely
 - unlikely
10. Which ways do you prefer to collect information? (choose only one)
- observe and describe.
 - make pictures.
 - write a report.

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

11. Mark the skills you think you can use in situations different from science class.

Skills	Math	Language	Home
Observation			
Prediction			
Interpretation			
Communication			

12. When you need to look for information, which way do you collect it? (choose one)

- a. internet searchers
- b. teacher suggested web pages
- c. library

13. Which graph do you prefer to use for showing progress in observations.

- a. line plot
- b. bar graph
- c. descriptive circle graph
- d. diagrams

14. Making descriptions of different events is

- a. very easy
- b. easy
- c. difficult
- d. very difficult

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Appendix B

Consent Letters

Bogotá, febrero de 2017

Padres de familia grado segundo

Gimnasio Colombo Británico Bilingüe Internacional

GCB

Asunto: Consentimiento Informado.

Mi nombre es Adriana Sánchez. Soy docente titular de la clase de *Science* en el Gimnasio Colombo Británico. Actualmente me encuentro cursando tercer semestre en la Maestría en Educación con Énfasis en Didáctica del inglés en la Universidad Externado de Colombia. Mi proyecto se titula "Diseño de materiales para el desarrollo de habilidades de indagación"; y tiene por objetivo la creación e implementación de materiales didácticos que permitan por medio de la solución de problemas mejorar las habilidades de indagación de los niños y niñas de grado segundo.

La investigación será conducida en el colegio en las clases de ciencias naturales (*Science*) y en la huerta escolar, se implementarán actividades, talleres y observaciones; de igual forma, se hará recolección de datos relevantes para el análisis los resultados por medio de la aplicación de una encuesta a los estudiantes, registro fotográfico de los avances del proyecto, donde no se incluirán sin los rostros de los estudiantes, notas de campo y materiales diseñados. Cualquier información recopilada a lo largo del proyecto será completamente confidencial y utilizada exclusivamente con fines académicos.

La participación es de carácter voluntario. Si su hijo(a) no desea participar en la implementación de los talleres no tendrá consecuencias en el desarrollo académico de la materia.

Este proyecto no tiene ningún riesgo para los niños y niñas. Por el contrario, me permitirá identificar las necesidades particulares e implementar estrategias que permitan mejorar sus habilidades de observación, predicción, elaboración de inferencias, conclusión al igual que la solución de problemas. Lo anterior, se espera verse reflejado y ser de ayuda no solamente en esta materia sino en las demás

Cualquier información adicional sobre este tema o a lo largo del desarrollo del proyecto, no dude en contactarme.

Gracias por su atención y colaboración,

Adriana Marcela Sánchez Beltrán

adriana.sanchez08@est.uexternado.edu.co

Nombre del padre\madre _____

Firma _____

Nombre del estudiante _____

Autorizó la participación del menor en la investigación. Si _____ No _____

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Bogotá, febrero de 2017

Señores

Junta Directiva

Gimnasio Colombo Británico Bilingüe Internacional

GCB

Respetados miembros de la junta:

Como es de su conocimiento, me encuentro cursando tercer semestre en la Maestría en Educación con Énfasis en Didáctica del inglés en la Universidad Externado de Colombia. Mi proyecto se titula "Diseño de materiales para el desarrollo de habilidades de indagación"; cuyo objetivo es la creación e implementación de materiales didácticos que permitan por medio de la solución de problemas mejorar las habilidades de indagación de los niños y niñas de grado segundo en el área de ciencias (Science Cambridge stage three).

Solicito su aprobación para implementar la investigación, asimismo es importante resaltar que las estrategias de investigación que se emplearán incluyen encuestas, observaciones de aula, desarrollo de las clases en el aula, laboratorio y huerta escolar y que acogeré y reconoceré la normatividad relacionada con la investigación y su incidencia en los seres humanos respetando el anonimato, integridad y confidencialidad de los participantes.

Adjunto el consentimiento informado que se utilizará para los padres de los estudiantes del curso seleccionado.

Gracias por su atención y colaboración,

Adriana Marcela Sánchez Beltrán

Maestra titular de Science Second Grade

adriana.sanchez08@est.uexternado.edu.co

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Appendix C

Field Notes Format

Teacher researcher: Adriana Sánchez		Date _____
Worksheet # _____		
Activity description:		
<p>Research question What does the implementation of teacher-designed materials focused on a Problem-based Learning approach reveal about inquiry skills in second graders at a private school?</p> <p>General objective: To implement teacher-designed materials on a Problem-based Learning approach to improve inquiry skills in second graders at a private school.</p> <p>Specific objectives. (a) To explore the appropriateness and usefulness of PBL materials in enhancing primary student's inquiry skills; (b) to analyze the way students solve a real context situation through a reflexive sequence; (c) to describe the process in which students make accurate inferences and draw conclusions about an observed event.</p>		
General Observations		Comments
Exploration stage		

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Guided inquiry stage	
Independent inquiry stage	

PROBLEM-BASED MATERIALS TO DEVELOP INQUIRY SKILLS

Appendix D

Focus Group Interview Questions

FOCUS GROUP INTERVIEW	
MD	
1.	What do you think about the materials used for this Project?
2.	What is the difference between this booklet and other school books you have?
3.	What was the most difficult part when handling the materials?
4.	What changes would you make in the materials?
PBL	
1.	What did you do when you had trouble solving something in the worksheets?
2.	Have you use any of the strategies you learnt in other subjects or at home?
3.	Do you feel you can solve problems and/or lead solutions?
4.	Why is it important to learn how to lead solutions?
IS	
1.	What did you learn about observation processes from this project?
2.	What did you learn about making predictions from this project ?
3.	Why is it important to learn how to interpret data?
4.	Which way do you prefer to communicate your results?