



PBL Methodology: Enhancing Science and Mother Tongue Integration

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Abstract

Curricular integration in school usually departs from a theme that reveals potential to interrelate knowledge from different disciplinary areas. However, an integrated approach can also be achieved by following a certain didactic line, problem situation or activity. In this study, a Problem Based Learning (PBL) methodology was implemented with the intention of promoting better learning in the fields of Science and Mother Tongue (Portuguese). This methodology has been used at different levels of schooling, especially related with Science learning, and our aim was to verify its potential to the improvement of expository text production. The participants were 44 pupils from the 4th grade of a primary state school, aged between 8-9 years old, divided into two groups (the experimental one and the control one). To achieve the established aim, three activities related to topics of the science syllabus were designed in accordance with PBL principles, that are: a) to present a problem that is relevant in a real context; b) to frame it using a real or a fictional scenario that can motivate pupils c) to give data sources to help its resolution; d) to promote collaborative work; e) to help pupils dealing with the proposed data sources through a tutorial process; f) to ask for a final product in which the answer to the problem is included; g) to assess all the learning process, presenting new situations that imply the knowledge acquired. The study took place during three months and the written productions of pupils were assessed with the help of grids for learning verification of scientific concepts and internalization of the key dimensions associated with written text production. The control group had a traditional approach of the contents of both disciplines. The results were particularly encouraging in the experimental group in terms of the presented aims, and revealed that the use of PBL can help learning in the two subject areas involved. It was also verified that the use of PBL activities had an impact on communication skills of pupils as well as in their motivation for learning.

Keywords: PBL; Expository text; Science learning

1. Introduction

The majority of teachers work with an imposed curriculum. Teachers have to accept it, interpret it and fulfil it at the level of content, objectives and even of activities and strategies which are often recommended in the syllabus and other guiding documents. Even so, and despite this real imposition, there are spaces of freedom of which teachers should be aware.

Bernstein's model of pedagogic discourse was a demonstration of the top-down power relations, established among all the agents of the educational system. This model also shows the components that influence educational system, with an emphasis on the economic and political powers ([1] Domingos et al, 1986).

However, even this model, which is still valid nowadays, allows us to understand how the official pedagogical discourse suffers a recontextualisation process at various levels, making this exercise of interpretation the first major space of freedom that teachers have at their disposal. Moreover, the pedagogical practice of each teacher, although increasingly controlled by evaluation mechanisms, persists as a space where some freedom is possible, especially in terms of "how" to teach.

The 1st cycle of schooling in Portugal (the first 4 years) is the cycle where teachers can exert their freedom more intensely as a result of some of its features. It works on a single teacher regime, and, consequently, each teacher can manage, by its own or in small teams, the planning of the different curricular areas and enhance forms of integration which are more difficult to achieve in the following cycles.

Several authors highlight the potentialities of an integrated curriculum. To [2] Beane (2000), in an integrated curriculum it is possible to achieve a unity and a higher degree of coherence. Also [3]



Jacobs (1989) argues that curriculum fragmentation, frequently promoted by schools, is detached from reality and from the complex nature of the problems we face every day.

Traditionally, integration is conceived through a theme or subject. However, integration can also be promoted during an activity, using a problem situation or by using a specific methodology or didactic line. It is in this latter context that the present work can be included as it aims to demonstrate the potential of PBL activities in Science and Mother Tongue learning.

2. Problem Based Learning and Language learning

Language is central to the learning of diverse types of knowledge and the linguistic specificities of each subject area should be understood as well as the matrix that puts them together. Strategies that promote the mastery of language facilitate, simultaneously, science learning. The work based on PBL favors the integration of knowledge, the integrated development of core competences in specific areas as well as a curriculum management that enhances the establishment of connections.

2.1 A Problem Based Learning origin and its main characteristics

PBL methodology was introduced in 1969, in the School of Medicine from the McMaster University in Hamilton in Canada, involving a class of twenty master's students. This new method had a major impact on medical courses worldwide and several universities started to adopt it. Gradually, PBL was introduced in other higher education courses in other subjects such as Chemistry, Physics, Earth Sciences and Mathematics, and also in non-higher education.

In the case of Portugal, some experiences of PBL implementation in non-higher education can be identified, as the examples reported by [3] Palma & Leite (2006), [4] Carvalho (2009), [5] Carvalho & Dourado (2013) and [6] Ferreira et al (2011), related to the learning of Physics and Chemistry and Biology and Geology in the 3rd cycle of schooling (between the 7th and the 9th year of schooling) and in Secondary school (between the 10th and the 12th year of schooling). In the 1st cycle, the adoption of PBL has been less frequent, therefore the relevance of the present work.

It is now important to present the general principles of the PBL methodology, which are the following:

- a) *To present a problem that is relevant in a real context.*
- b) *To frame it using a real or a fictional scenario that can motivate pupils.*
- c) *To give data sources to help its resolution;*
- d) *To promote collaborative work.*
- e) *To help pupils dealing with the proposed data sources through a tutorial process.*
- f) *To ask for a final product in which the answer to the problem is included.*
- g) *To assess all the learning process, presenting new situations that imply the knowledge acquired.*

2.2 Expository text to learn to science

Reading and writing to learn and to build knowledge presupposes the understanding and the production of texts by students. This production requires specific cognitive strategies that allow to activate prior knowledge, to anticipate content, to organize new information, to question about the information used, and to build a mental representation of the content. During this process the student also uses self-regulation strategies in the process of acquisition and construction of learning ([7] Giasson, 1995; [8] Cartier, 2007).

To learn science, reading is one of the most immediate vehicles, to the extent that it allows access to information in a direct way, enabling students to acquire knowledge in different fields presented in different manners and in different supports. It is, as advocated by [9] Giasson (2011), an interactive process between the reader and the text, through which the first reconstructs the meaning of the second, ie, simultaneously, the reader draws and builds meaning.

To this end, the expository text is, par excellence, the most adequate text genre for science learning, since it is the one that presents and explains scientific concepts. It is a genre characterized by having a clear and objective language, allowing for more efficient acquisition of knowledge.

3. Methodology

In this study, the use of a research-action methodology is intended to demonstrate the contribution of PBL for a better acquisition of the processes conducting to the elaboration of expository texts and for the learning of scientific concepts. To further verify the effectiveness of the PBL methodology, a quasi-experimental was also designed with a control group and an experimental group.



3.1 Participants

The sample included 43 pupils from the 4th year of schooling, 23 included in the experimental group and 20 in the control group. Their age was between 8 and 9 years old. They were from two different classes from an urban school, attended by low-middle class pupils.

3.2 Procedures

Initially, in the first phase, a pre-test was applied to both groups.

In the second phase, three activities reflecting the PBL principles were applied to the experimental group, related to the following science topics: the stars, the water cycle and the characteristics of the Portuguese coast.

In the third and final phase, a post-test was applied to the two groups.

The pre-test and post-test were similar in both groups and consisted of a writing proposal related to the theme "earthquakes". Data sources were provided to each student. The theme included in the pre-test and post-test was different from the ones presented in the PBL activities because the objective was to verify if this methodology fosters the improvement of pupils' skills in science learning, using the production of expository texts with a positive effect in the understanding of the features of this type of text.

For analysis of the expository texts produced by pupils, several parameters were defined and grouped into three main categories:

- 1) Compositional skills: "Gives a title", "Identifies the theme", "Uses text organizers". These were encoded using "yes" or "no" depending on their presence in the text. The parameters "Organizes information", "Exposes characteristics", "Structures statements correctly" and "Uses scientific vocabulary" were coded with a scale from 0 to 3.
- 2) Writing Processes: "Planning", "Uses planning", "Integrates graphics" and "Associates graphics to the text" were encoded with "yes" or "no"; "It uses information", "Selects Information" and "Writes autonomously" were coded with a scale from 0 to 3.
- 3) Scientific concepts: The concepts were different in each PBL activity and their presence was coded with a scale from 0 to 3.

The meaning of the scale was the following: "0", did not include; "1", makes a small reference; "2", makes an almost complete reference; "3", makes a complete reference.

4. Results

The results will focus only on the comparison of the pre-test and post-test between the two groups, knowing that the learning process between them was different. By comparing the results of the two groups, it turns out that in the pre-test both groups had similar performances in all parameters relating to Compositional Skills and Writing Processes, except in the indicators "Gives a title", in which 74 % of the pupils of the Experimental Group (EG) gave a title to the text against 10% of the pupils of the control group (CG); "Identifies the theme," which occurred in 95% of the EG and in 25% of the CG and "Writes autonomously" that was verified in 47.9% of the EG and in 30% of the CG. In the Scientific concepts category, major differences were found in all indicators.

In the indicator "Define earthquake", 69.5% of the pupils of the EG performed favorably against 55% of the pupils of the CG; in "Identify types of earthquakes", the results were 69.5% in the EG versus 45% in the CG. However, the results were below 50% for both groups, in the following indicators: "Understands the meaning of epicenter" (21.6% EG, 0% CG); "Associates earthquakes to the movement of plate tectonics" (47.7% EG, 55% CG), "Recognizes the Richter scale" (17.2% EG, 10% CG).

In the post-test, the differences between the two groups remained for all categories, but, at the same time, both groups advanced proportionally. The experimental group performed better in the following indicators: "Identifies the theme," 100% against 80% in the control group; "Exposes characteristics", 91.2% in the EG and 60% in the CG and "Uses scientific vocabulary", 91.2% of positive performance in the EG against 65% in the CG.

A similar progression also occurred related to the scientific concepts indicators: "Define earthquake" (91,2% EG, 75% CG); "Identify types of earthquakes" (65,1% EG, 60% CG); "Understands the meaning of epicenter" (73,8% EG, 0% GC); "Associates earthquakes to the movement of plate tectonics" (85,9% EG, 75% CG); "Recognizes the Richter scale" (34,7% EG, 0% CG).

Although both groups have improved in the post-test, the performance of the EG was higher and more consistent in both learning areas, in particular in the specific characteristics of the expository test,



which implies the use of a specific structure and vocabulary, as well as in the use of scientific concepts in the final writing production.

5. Conclusions

This study allows us to state that the PBL methodology reveals a great potential, both in terms of scientific knowledge acquisition and in terms of expository text production. Working with continuity in data sources, the request of the final product and the application task are aspects that were central for the pupils' success. Of course, the control group also improved in some areas, which was expected, since they also discussed the same scientific issues, as well as the characteristics of the expository text. But the improvement was less significant, a fact which reinforces the potential of PBL methodology to promote integrated curriculum approaches.

References

- [1] Domingos, A. M., Barradas, H., Rainha, H. & Neves, I. P. (1986). *A Teoria de Bernstein em Sociologia da Educação*. Lisboa: Fundação Calouste Gulbenkian.
- [2] Beane, J. A. (2000). O que é um currículo coerente? In J. A. Pacheco (Org.). *Políticas de integração curricular*. Porto: Porto Editora.
- [3] Palma, C. & Leite, L. (2006). Formulação de questões, educação em ciências e aprendizagem baseada na resolução de problemas: Um estudo com alunos portugueses do 8.º ano de escolaridade. In *Atas Congreso Internacional PBL 2006 ABP*. Lima (Perú): Universidade Pontificia Católica.
- [4] Carvalho, C. J. (2009). *O Ensino e a Aprendizagem das Ciências Naturais através da Aprendizagem Baseada na Resolução de Problemas: um estudo com alunos de 9.º ano, centrado no Sistema Digestivo*. (Masters dissertation) Braga: Universidade do Minho.
- [5] Carvalho, C. & Dourado, L. (2013). Proposta de uma Tipologia de Cenários usados na Aprendizagem Baseada na Resolução de Problemas. In B. Silva, L. Almeida, A. Barca, M. Peralbo, A. Franco & R. Monginho (Edits). *Atas do XII Congresso Internacional Galego-Português de Psicopedagogia* (pp. 2746-2763). Braga: Universidade do Minho.
- [6] Ferreira C., Alencão A., Vasconcelos C. (2011) Preservação da biodiversidade em áreas degradadas: Uma intervenção centrada na Aprendizagem Baseada na Resolução de Problemas. *Atas do XIV Encontro Nacional de Educação em Ciências* (p.349-362). Braga: Instituto de Educação da Universidade do Minho.
- [7] Giasson, J. (1995). *A Compreensão na leitura*. Porto: Edições ASA.
- [8] Cartier, S. (2007). *Apprendre en lisant au primaire et au secondaire : Mieux comprendre et mieux intervenir*. Anjou: Éditions CEC.
- [9] Giasson, J. (2011). *La lecture: Apprentissage et Difficultés*. Montréal: Gaetan Morin Éditeur.