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ANALYSIS OF THE CONCEPTUAL AND PROCEDURAL CONTENTS LEARNING IN A DISTANCE LEARNING COURSE FOR TEACHERS

ANÁLISE DA APRENDIZAGEM DE CONTEÚDOS CONCEITUAIS E PROCEDIMENTAIS EM UM CURSO A DISTÂNCIA PARA PROFESSORES

ANÁLISIS DEL APRENDIZAJE DE CONTENIDOS CONCEPTUALES Y PROCEDIMENTALES EN UN CURSO A DISTANCIA PARA MAESTROS

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RESUMO

Neste trabalho, analisamos a aprendizagem conceitual e procedimental em um curso a distância de formação de professores para a inserção da Antártica no currículo escolar. Os instrumentos de investigação foram um questionário com quinze afirmações, aplicado antes e após o curso e um projeto polar desenvolvido pelos cursistas na turma de 2020. Participaram 138 professores de 25 estados brasileiros. Analisamos a ocorrência de aprendizagem conceitual e identificamos alguns erros conceituais. Os projetos polares permitiram verificar os temas e procedimentos adotados e se houve conhecimento construído durante o curso. As análises mostraram que, apesar de o tema ser desconhecido da grande maioria, o curso contribuiu para a inserção significativa da Antártica no currículo escolar.

Palavras-chave: Antártica. Pedagogia de projetos. Avaliação da aprendizagem. Formação de professores.

ABSTRACT

In this work, we analyze conceptual and procedural learning in a distance course for teacher training for the introduction of Antarctica into the school curriculum. The research instruments were a questionnaire with fifteen statements, applied before and after the course and a polar project developed by the students in the 2020 class. One hundred thirty-eight professors from 25 Brazilian states participated. We analyzed the occurrence of conceptual learning and identified some misconceptions. The polar projects made it possible to verify the themes and procedures adopted and whether knowledge was built during the course. The analysis showed that, despite the theme being unknown to the vast majority, the course contributed to the significant inclusion of Antarctica in the school curriculum.

Keywords: Antarctica; project-based pedagogy; learning assessment; teacher training.

RESUMEN

En este trabajo analizamos el aprendizaje conceptual y procedimental en un curso a distancia de formación docente para la inserción de la Antártida en el currículo escolar. Los instrumentos de investigación fueron un cuestionario con quince enunciados, aplicado antes y después del curso y un proyecto polar desarrollado en la classe de 2020. Participaron 138 profesores de 25 estados brasileños. Analizamos la ocurrencia del aprendizaje conceptual e identificamos muchos errores conceptuales. Los proyectos polares permitieron verificar los temas y procedimientos adoptados y si hubo conocimiento construido durante el curso. Los análisis mostraron que, a pesar de que el tema era desconocido para la mayoría, el curso contribuyó a la inclusión significativa de la Antártida en el currículo escolar.

Palabras-clave: Antártida. Padagogía basada en proyectos. Evaluación del aprendizaje. Formación de profesores.

INTRODUCTION

Indeed, issues related to the Antarctic, e.g., climate change, sea-level rise, ocean circulation (BECK, HUFFMAN, XAVIER, & WALTON, 2014; BETTELEY, HARR, & LEE JR, 2013; CHOWN & BROOKS, 2019; CONSTIBLE, SANDRO, & LEE JR, 2007; KENNICUTT et al., 2014; PRIESTLEY, DOHANEY, ATKINS, SALMON, & ROBINSON, 2019; RINTOUL et al., 2018) have the potential to affect millions of Brazilians lives, schools and universities have a significant lack of reliable information about the Antarctic. However, as noted, among others, by CARAMELLO et al. (2017); L. C. RODRIGUES, SANTOS, MELO, and ALENCAR (2014); ZANANDREA, RODRIGUES, and ALENCAR (2018), the approach to the theme of Antarctica in Basic Education is scarce. The Common National Curriculum Base (BNCC), the most recent document approved by the Ministry of Education (BRASIL, 2018), cites Antarctica only once.

The BNCC (BRASIL, 2018), a 600-page document, has a normative character and defines the set of essential learning that all Brazilian students must develop. Despite proposing the study of climate, climate change, greenhouse effect, and other topics related to the continent, it only appears in the context of the skills to be developed in the Geography discipline in the 8th year of elementary school. Other learning possibilities were neglected.

On the other hand, the understanding that it is necessary to expand access to Science to different audiences is increasingly present in the scientific community. When discussing the points to guarantee the quality of Science and Technology (S&T) actions within the scope of research in Antarctica, the Antarctic Science Action Plan 2013–2022 (SIMÕES et al., 2013) highlights the importance of the dissemination and social insertion of knowledge generated by Brazilian Antarctic research. It proposes increasing disseminating

research in Brazilian society, education actions, and science popularisation by communicating through new media and e-learning projects.

Successful experiences are those in the UK and Australia. The first offers teachers a set of materials organized and connected to the national curriculum through the Discovering Antarctica (BRITISH ANTARCTIC SURVEY, 2020). The second offers contents and activities also connected to the national curriculum (AUSTRALIAN ANTARCTIC PROGRAM, 2012). Antarctica is a mandatory topic in the Argentinian curriculum, and there is a, but it still does not have a structured teacher training program. Through the Gaia Institute of the University of Magalhães, Chile offers content proposals to engage students in activities to study Antarctica (UMAG, 2020). Other experiences of introducing Antarctic themes in Education were also reported by (BECK et al., 2014; BETTELEY et al., 2013; POUND et al., 2019; PRIESTLEY et al., 2019; WARBURTON, HADEMENOS, EILERS-GUTTENSOHN, GARAY, & WORSSAM, 2019; XAVIER, MATEEV, CAPPER, WILMOTTE, & WALTON, 2019). All these experiences have contributed to the reflection on strategies for introducing Antarctica into the curriculum.

For this reason, in 2014, we developed and implemented the course *Antártica ou Antártida*[1]*? How to introduce polar sciences in the Basic Education curriculum (AA?)*. It is a distance learning course for teachers to show that the Antarctic themes can be articulated together with the national curriculum contents on physical space, geography, climate, history, and biology. The objective is to strengthen society's knowledge about the importance of Antarctic research and its relevance to Brazil and the planet, to build local and global environmental awareness through the school system. Among other objectives, the course seeks to increase the dissemination of research in Brazilian society, as proposed by the aforementioned Action Plan (SIMÕES et al., 2013, p. 30). There is also an expectation that teachers will collaborate to implement an innovative curriculum (VOOGT, PIETERS, & HANDELZALTS, 2016) by incorporating Antarctic themes into their educational practice.

The course is conducted through project-based pedagogy. The essence of Project based learning is that a question or problem serves to organise and drive activities, whose

[1] In Portuguese, both terms are accepted, and this ends up causing doubts among people, hence the choice of the name for the course

main focus is on collaborative learning (THURLINGS & DEN BROK, 2018). These activities culminate in a final product that addresses the driving question (BLUMENFELD et al., 1991) cited by (HELLE et al., 2006).

The projects can be a centerpiece of interdisciplinary learning in the classroom. As (ARAÚJO, 2008) highlights, learning to think critically requires giving meaning to information, analyzing it, synthesizing it, planning actions, solving problems, creating new materials or ideas, and becoming more involved in the learning task, a process especially favored by project-based pedagogy.

Learning is assumed to take place through the use of mental tools such as concepts and theories, while the students' attention is not directed to the improvement of mental structures per se but to the productive activity of making meaning (HELLE et al., 2006).

It offers introductory content on some Antarctic themes, but the teachers will define what will be studied based on the project that they will create and conceptual contents can be directed and implemented from procedural learning based on project-based pedagogy. Conceptual learning is related to learning knowledge that allows searching, selecting, analyzing, understanding, and recreating information. Procedural learning refers to the technical mastery or symbolic code. Conceptual contents refer to the active construction of intellectual capacities to work with symbols, ideas, images and represent implement in their classroom. In project-based pedagogy (ARAÚJO, 2008), learning needs appear in attempts to solve problem situations. The students get involved in the creation, development, and implementation of an interdisciplinary project. There is learning through research and the development of autonomy, as students need to develop their own study strategies, defining the theme, objectives, and methodology to carry out the project. With project-based pedagogy, the course can meet the diverse public: teachers from early childhood education to youth and adult education (YAE) and higher education, with different backgrounds between pedagogy, bachelor degrees, and various areas of knowledge, and originating from other Brazilian regions and cultures.

The assumption is that conceptual contents can be directed and implemented from procedural learning based on project-based pedagogy. Conceptual learning is related to learning knowledge that allows searching, selecting, analyzing, understanding, and recreating information. Procedural learning refers to the technical mastery or symbolic

code (MORIN, 2002). Conceptual contents refer to the active construction of intellectual capacities to work with symbols, ideas, images and representations that allow organizing reality. Learning concepts allows assigning meanings to the learned content and relating them to others. Procedural Contents: express know-how, which involves making decisions and carrying out a series of actions, in an orderly and non-random way, to achieve a goal. When teaching procedures, a particular way of thinking and producing knowledge is also taught (DOTTA, 2003).

According to Atmoko, Praherdhiono, and Adi (2020) a procedural learning is often associated with traditional learning and associated with monotonous learning behavior, less interaction, and less dialogue with other learners. On the other hand, (BARRON & DARLING-HAMMOND, 2008) point out that Project-based learning is a pathway to deeper knowledge as it uses an active learning style that that typically result in a realistic product, event, or presentation to an audience.

Kokotsaki, Menzies, and Wiggins (2016) present an overview of the evidence for the effectiveness of Project-based learning and relate that the majority of these studies were based on a quasi-experimental pretest–posttest design with some baseline equivalence established for the outcomes measured at the classroom level. Furthermore, Kokotsaki and colaborators (2016) summarise some factors that can facilitate the adoption of project-based teaching instruction in the classroom, such as, Student support, Teacher support, Effective group work, Balancing didactic instruction with independent inquiry method, Assessment emphasis on reflection, self and peer evaluation, student choice and autonomy.

Unlike the countries mentioned earlier, which offer ready-to-use resources in the classroom, in the Antarctica or Antarctica course, the conceptual contents to be learned by the teachers participating in the course, and its possible connections with the curriculum, are not necessarily given by the course material. Still, they can, instead, be constructed in the trajectories of project elaboration proposed by the course methodology.

In this work, we primarily investigate the learning of conceptual and procedural contents in order to verify if, during the course, the teachers gained knowledge (i) about the continent and (ii) about how to mediate their students' learning about Antarctica in

the context of school subjects. Finally, we try to answer some key questions: Is it possible to teach and learn about Antarctica in a non-content course? Is project-based pedagogy an appropriate methodology for learning and teaching about Antarctica? What are the most suitable themes to articulate with Antarctic knowledge in the school curriculum? What were the conceptual and procedural contents learned and retained during the course? Does the Antarctic course contribute to scientific dissemination? What is the best way to expand the scientific dissemination potential of the Antarctic course?

METHODOLOGY

This work originates from a distance learning course that used the Project-Based Pedagogy approach. After the course had finished, we decided to analyze the results obtained, seeking to identify the gains in the process.

We adopted the same didactic-pedagogical approach for all students during the classes, with no experiments or control groups. The applied questionnaires were part of the discipline's evaluation strategy, with diagnostic and educational purposes, thus not requiring extra student dedication. The same went for the projects developed by the students within the scope of the discipline and analyzed in this work. The raw data were pre-processed by the teacher responsible for the class in order to be able to compare the pre-test and post-test results. For the analysis and discussion in this work, we processed all data anonymously, safeguarding the privacy of the respondents.

The course was conducted through the virtual learning environment Moodle. To participate on it was mandatory to be a Brazilian public school teacher. 5% of the vacancies were allocated to other audiences, such as undergraduate professors and professionals who work in parks and museums and teachers from other countries. The 2020 class had 138 participants. Most of them are Basic Education teachers from 25 Brazilian states, two from Portugal and one from Chile.

The following instruments were used to investigate whether there was learning of conceptual and procedural contents: Questionnaires and Polar Project. Both instruments are detailed as follows.

Questionnaires

Before starting the course, a questionnaire with fifteen statements (pre-test) about the Antarctic continent was applied, as shown in Table 1, so that course attendees could answer with true or false. Column 1 shows the statement number. In column 2, the statement. In column 3, the letter F for a false statement and T for a true statement. In column 4, N is for a statement whose content is not covered in the course, and Y for content addressed explicitly in the course materials.

Statement Q07, "The exploration of Antarctica began in the 19th century", was disregarded in the analysis because of the ambiguous concept of "exploration/exploitation." Among the fourteen remaining statements, eight address content covered explicitly by course materials (primary text, video lessons, scientific videos, games). To answering the others six statements, it is necessary to use either previous knowledge or external sources through research. After completing the course, the same questionnaire (post-test) was applied and answered by the 138-course attendees. Data from both questionnaires were cross-checked for analysis.

Table 1 - Statements about Antarctica present in the questionnaire.

N	Statements	Correct?	Is it covered in the course?
Q01	Antarctica (anti-arctic) is an ice cap on the opposite side of the Arctic.	F	N
Q02	Antarctica is at the South Pole.	F	N
Q03	There are several species of penguins and other birds inhabiting Antarctica.	T	Y
Q04	Each country keeps a territory in Antarctica.	F	N
Q05	Antarctic natives are known as Eskimos.	F	N
Q06	Seals and sea lions are the only land animals in Antarctica.	F	Y
Q07	Antarctic exploration began in the 19th century. (not analyzed in this paper)	?	?
Q08	Polar bears do not eat penguins, as they prefer fish.	F	N
Q09	Antarctic krill is a species of shrimp found in Antarctica.	T	Y
Q10	The emperor penguin lives in Antarctica.	T	Y
Q11	Japan hunts whales in Antarctica.	T	Y
Q12	The largest concentration of fresh water in the world is in Antarctica.	T	Y
Q13	Icefish are not consumed by humans, as they melt when removed from the icy waters of Antarctica.	F	N
Q14	The orca, known as the killer whale, is a dolphin.	T	Y
Q15	Comandante Ferraz is the Brazilian base in Antarctica.	T	N

Polar Project

Because we adopted project-based pedagogy as a teaching methodology, the course's main evaluative activity was developing an individual or group Polar Project, addressing one of the themes covered in the course modules: Life, Ice, Environment, or Convergence. We used multiple references to create each module, such as: (AUSTRALIAN ANTARCTIC PROGRAM, 2012; AUSTRALIAN GOVERNMENT, 2015; BAUGHMAN, 1997; BRITISH ANTARCTIC SURVEY, 2020; CLIMATE EMERGENCY, 2014; CONTI, 2005; DENNY et al., 2011; GOLDEMBERG et al., 2011; IPCC, 2014; MADRID PROTOCOL, 1991; TURNER et al., 2005) and others.

The Life module introduces the region's fauna and flora. Environment discusses Antarctica's climatic influences on the rest of the planet. Ice explains the Antarctic ice variations and its characteristics. The Convergence module provides an overview of the history of the continent's discovery, the era of hunting, the heroic era, and the contemporaneity governed by the Antarctic Treaty and the Madrid Protocol.

Developing a Polar Project had the objective of leading the course participant to apply a project in their classroom, contemplating content and methodologies offered by the course AA? Participants could use the transmedia created by the course developers or create their own narratives. "Offering transmedia formats that include narratives prepared by the course participants is one of the didactic strategies to favour communicative and digital skills and also has very positive effects on engagement in the topics studied" (CASTAÑEDA, 2021).

The Polar Project has stages with weekly submissions and is created and developed in groups or individually to introduce Antarctica in the school. Therefore, for course certification, all projects must be applied in the classroom and must have their results evaluated in an experience report.

The analysis of procedural content learning for the 2020 class was limited to the type of mediation conducted by course participants during the creation of the Polar Projects. As a method of analysis, the final texts of the 84 Polar Projects were considered and read in detail which contained the following elements: theme according to the structure of the course itself, Environment, Life, Ice, Convergence; school level: Early

Childhood Education, Elementary School I, Elementary School II, High School, and Higher Education; discipline: name of the disciplines involved; contents: keywords, extracted from the objectives and contents covered; and teaching methodology: traditional or active.

We tabulated data using Excel and created seven tables and three graphs for data visualization and analysis.

RESULTS AND DISCUSSION

This section aims to discuss the results from the analysis of the questionnaires and the Polar Projects.

Questionnaires Analysis

Analyzing the questionnaire (14 Questions) allows verifying if there was learning of conceptual contents during the course. Table 2 presents the descriptive measures obtained from the results of students in the pre-test (gradeBegin) and post-test (gradeEnd) using the Jamovi Statistical Analysis tool2. The preand post-tests of all 138 participants who completed the course were analyzed.

Table 2 - Descriptives Statistic.

Itens	gradeBegin	gradeEnd
N	138	138
Missing	0	0
Mean	7.03	8.14
Median	7.33	8.67
Standard deviation	1.30	1.03
Minimum	4.00	3.33
Maximum	10.0	10.0
25th percentile	6.00	7.33
50th percentile	7.33	8.67
75th percentile	8.00	8.67

The Pre-Test (gradeBegin) average was 7.03 and in the Post-Test (gradeEnd) was 8.14, indicating an improvement in the results at the end of the course. We present below the steps used to verify the hypothesis.

[2] https://www.jamovi.org/

It is noteworthy that we are working with paired groups. That is, the same student was evaluated before and after the course. To choose the type of test to be performed initially, the Normality Test (Shapiro-Wilk) was applied. The result of p = 0.003 (p < 0.05), as shown in Table 3, indicates the violation of the assumption of normality. Therefore, the data does not present a normal distribution. Thus, the test chosen to verify the hypothesis was Wilcoxon signed-rank.

Table 3 - Normality Test (Shapiro-Wilk).

	W	*p*
gradeBegin gradeEnd	0.968	0.003

The result of applying the Wilcoxon signed-rank test presented in Table 4 showed that p < 0.001. Thus, with p being minimal (p < 0.05), confirm a significant difference between the results before and after the course. The descriptive measures also attested an improvement in the results in all quartiles: first (6.00; 7.33), second (7.33; 8.67), and third (8.00; 8.67).

Table 4 - Wilcoxon signed-rank test.

			Statistic	**p**
gradeBegin	gradeEnd	Wilcoxon W	646[a]	<.001

[a]25 pair(s) of values were tied

Table 5 shows the comparison between the answers given before the course started (pre-test) and after its conclusion (pos-test). 70.8% of the course attendees' responses before the course started were correct. After completing the course, the correctness rate increased to 82.6%. Questions Q01, Q02, Q06 and Q13 had a negative variation, with a slight reduction of correct answers, with -2.2%, -6.5%, -2.2%, and -3.6%, respectively. All others showed an increase, in some cases significant, in the number of correct answers. The questions Q01, Q02, Q05, Q08, Q13, and Q15 addressed content not covered in the course, yet, three of them had an increase in the number of correct answers, Q05 increased by 17.4%, Q08 increased by 10.9%, and Q15 increased in 16.7% the number of correct answers. This result still does not affirm that there was a learning of procedural contents, as these may have already been part of the course attendees' previous skills.

However, it suggests the course attendees' efforts to learn autonomously, for example, through research, about content not explicitly addressed by the course.

Regarding the learning of conceptual contents, it is worth mentioning that the first time the questionnaire was applied, it sought to assess the course attendee's previous knowledge before the course started. It is known that the formal education system does not build understanding about Antarctica, as some studies have already shown (BRASIL, 2006a, 2006b; RODRIGUES, 2017; L. C. RODRIGUES et al., 2014; SILVEIRA et al., 2014). The expectation was for a low index of correct answers, or even that some answers show the conceptual errors widely accepted by society. One example is statement Q02. Antarctica is at the South Pole. Indeed, the South Pole is in Antarctica, but people commonly refer to Antarctica as the South Pole.

Another example is Q14. The orca, known as the killer whale, is a dolphin. In Portuguese, the orca is a feminine pronoun, and the dolphin is masculine. Also, the English term for this animal is Killer Whale. These aspects lead to the idea of the orca as being a whale and not a dolphin. Despite the low expectation of correct answers, Table 4 shows the variation of correct answers for each statement. Statements Q01, Q02, Q06, Q13 had worse responses. The statements Q01 (-2.2%) and Q02 (-6.5%) address content not treated explicitly in the course materials, while Q06 (-2.2%) and Q13 (-3.6%) refer to the content covered by the course. It is not possible to state that the persistence of errors or worsening performance is related to the fact that some statements are not addressed in the course. One hypothesis to explain these errors is that some course attendees may have simply guessed. All other statements show improvement in the correct answers, including Q05 (+ 17.4%) and Q08 (+ 10.9%), whose contents are not referenced in the course.

Table 5 - Comparison between correct answers before (pre-test) and after (post-test) the course.

	Before the beginning		At the end of the course		Difference (begin/end)	
N	Quantity Correct Answer	% Correct Answer	Quantity Correct Answer	% Correct Answer	Quantity	%
Q01	78	56,50%	75	54,30%	-3	-2,20%
Q02	18	13,00%	9	6,50%	-9	-6,50%
Q03	118	85,50%	128	92,80%	10	7,20%
Q04	116	84,10%	131	94,90%	15	10,90%
Q05	105	76,10%	129	93,50%	24	17,40%

Q06	118	85,50%	115	83,30%	-3	-2,20%
Q08	115	83,30%	130	94,20%	15	10,90%
Q09	101	73,20%	123	89,10%	22	15,90%
Q10	112	81,20%	123	89,10%	11	8,00%
Q11	57	41,30%	105	76,10%	48	34,80%
Q12	96	69,60%	128	92,80%	32	23,20%
Q13	134	97,10%	129	93,50%	-5	-3,60%
Q14	88	63,80%	133	96,40%	45	32,60%
Q15	112	81,20%	135	97,80%	23	16,70%

Statements Q11 and Q14, both on marine mammals in Antarctica, had a significant increase in scores. Statement Q11, Japan hunts whales in Antarctica, had a 34.8% increase in correct answers. The hunting of marine mammals is a theme discussed in depth in the Convergence module. The history of the discovery of the continent is related to whaling in the 19th century. This action almost led many species to extinction in the 20th century. The subject of the protection of these animals is increasingly relevant in the international debate. In addition to the introductory text and a handout on marine mammals, seven video classes deal with mammals and deepen the discussion on hunting in the course. The amount of information and activities related to the topic can play an essential role in the course attendees' learning and improving their answers. Statement Q14 addresses a common conceptual error: "The Orca, known as the killer whale, is a dolphin." It was expected that after studying the course materials, this error would decrease, and there was an increase of 32.6% in the number of correct answers in the second questionnaire. Q14 was one of the statements with the highest number of correct answers by course participants (133 correct, as shown in Table 5).

As shown in Figure 1, when observing the evolution of course attendees before and after the course, 71% recorded an improvement in responses, 18.1% maintained the same correct rate, and 10.9% worsened. After completing a course, its participants are expected to expand their knowledge, so it was expected that there would be a significant improvement in the correct answers, as recorded. However, the data do not allow us to understand or make inferences about the cases that worsened their performance in the answers.

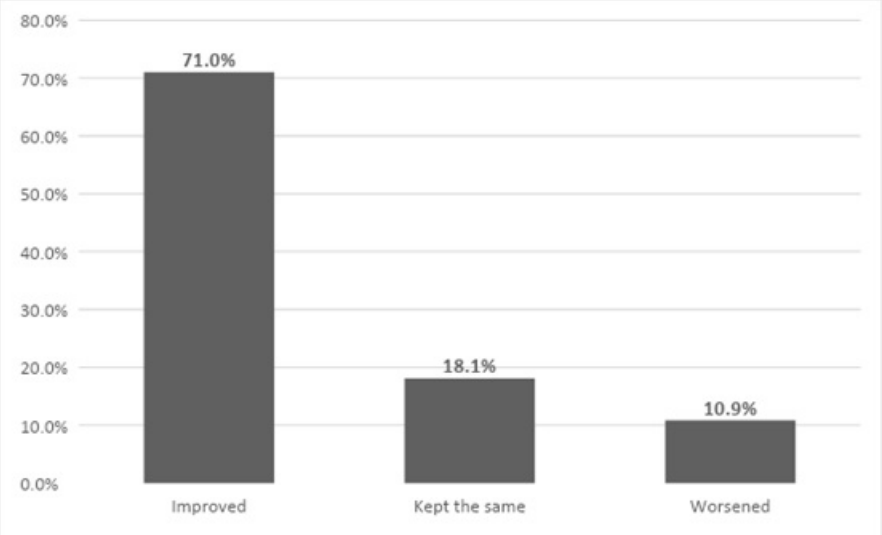

Figure 1 - Evolution of correct answers before and after the course
Fonte: Elaboração própria.

Figure 2 allows the visualization of the improvement of correct answers per participant. The first section of each strip (in green) presents the percentage of students who improved their performance concerning the statement. The second section (in blue) shows how many maintained their correct answers given in the first questionnaire. The third section (in yellow) shows the percentage of students who had answered correctly in the first questionnaire but changed their answer in the second, that is, had answered the first time correctly. Also significant are the students who improved their performance in most other statements, showing the occurrence of learning the conceptual contents addressed in the teacher training process. However, it is worth noting the significant worsening of course attendees in Q01, Q02, and Q06. Although statement Q01, "Antarctica (anti-arctic) is an ice cap that is on the opposite side of the Arctic," is not explicitly addressed in the course, throughout the introductory text, the entry "continent" is repeated 41 times, in addition to countless references to the continent in video classes and scientific videos. As already explained, the statement Q02, "Antarctica is at the South Pole," is a widespread conceptual error. 10.1% of the students who had answered the first questionnaire correctly were wrong the second time. As already described, this statement's content is not addressed explicitly in the course. The absence of an Antarctic identity in Brazilian culture, different from what happens in countries like Chile (BARTICEVIC et al., 2014) and Argentina (GARCIA, 2009), which have long Antarctic

traditions, contributes to common sense formed by myths and misconceptions (SIMÕES, 2013)

Also noteworthy are the statements Q05, "Natives of Antarctica are known as Eskimos," and Q08, "Polar bears do not eat penguins, as they prefer fish.": 21% of course attendees improved their performance on Q05, compared to 3.6% that worsened, and 14.5% improved on Q08, compared to 3.6% that got worse. Both statements bring content not explicitly addressed in the course, whose learning depended on the teacher's research initiative.

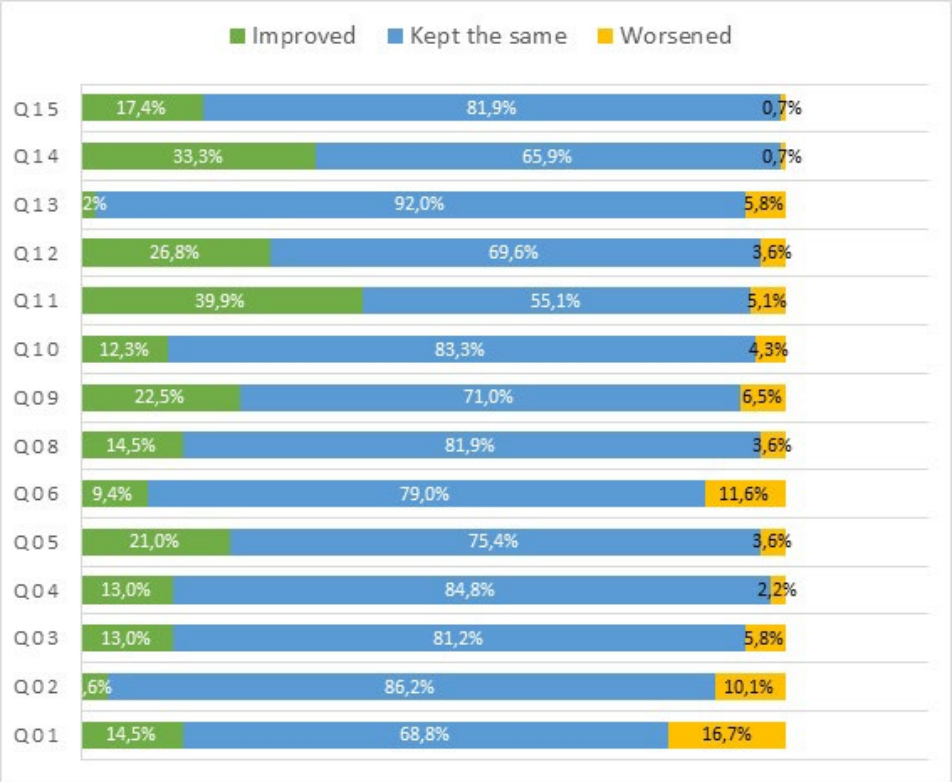

Figure 2 - Comparison of performance by attendees' course before and after the course
Fonte: Elaboração própria.

The analyses showed that AA? promoted the learning of different conceptual contents and contributed to the correction of conceptual errors arising from common sense, such as the concept of the orca being commonly called a whale when in fact, it is a dolphin. Therefore, it is assumed that this improvement results from autonomous learning through research, procedural learning.

Polar Projects Analysis

The analysis of the 84 Polar Projects developed by the course intends to help understand two aspects: the learning of conceptual contents and procedural content learning.

When analyzing the teachers' learning, it is necessary to recognize the context in which this group works. They are committed to participating in a training course with professional development objectives. Currently, teachers seek to prepare themselves to enforce the *BNCC Base Nacional Comum Curricular* (National Common Curricular Base) (BRASIL, 2018). In this sense, it is considered that the conceptual contents addressed by the Polar Projects are aligned with the contents proposed by the BNCC. The first analysis refers to the selection of the Polar Projects themes, as shown in the Table 6. Environment was the most addressed by projects, with 43.8%, followed by the Life theme, 27.5%, Convergence, 21.3%, and Ice, with 7.5%. The themes Environment and Life, with greater representation in the Polar Projects, offer a close relationship with Brazilian contexts, the BNCC (BRASIL, 2018), and the school curriculum. The variation of the weather and temperature in Brazilian regions, due to the influence of air masses coming from Antarctica (CARPENEDO et al., 2008) and the connections between Antarctic marine animals, migrating, or not, to the Brazilian coast, are tangible and, therefore, favor the discussion of fauna in the classroom.

As Brazil is a tropical country, Ice theme possibly is not as attractive as it seems distant from Brazilian reality. However, it is known that ice cores show the geological history of the Earth because they hold information from thousands and even millions of years ago. Although educational course materials address this, the subject was rarely considered in projects.

As it addresses the history of the continent's discovery, Convergence is a theme far from the school curriculum's conceptual horizon. Since no Brazilians have participated in the periods of exploration, hunting, and discovery of Antarctica, different from countries with a past closer to the continent's exploration, such as Argentina, New Zealand, Australia, England, however, an essential part of this course module should be highlighted in the projects: geopolitics and the Antarctic Treaty, to which Brazil is a signatory, the Madrid Protocol, an international environmental preservation agreement on the continent and which is of great importance for Brazilian and South American environmental health.

Brazil's geopolitical interest in Antarctica is directly related to national sovereignty and its implication on the international scene, as, for example, a producer of quality science. These aspects were considered by only 17.3% of the Polar Projects.

It can be verified that procedural content learning led to conceptual content learning. That was demonstrated in comparing the answers given to some questions whose contents do not compose the course materials and the sub-themes treated in the contents of the polar projects created by course attendants.

On the other hand, fundamental themes contained in the Ice and Convergence modules have been scarcely addressed and leave some gaps, such as Antarctic geopolitical interest to Brazil. Those gaps are concerning research in Science Teaching and Scientific Disseminate and teacher training: what strategies are adequate to highlight the importance of these themes for the school curriculum and its critical approach to teaching.

Most of the projects (49,4%) were applied in Elementary School (ES), followed by 30.6% in Middle School (MS). These two levels (ES + MS) total 80% (49.4+30.6=80) of the projects' application. Only 8.1% of the projects were applied in High School (HS) and 5.0% in Pre-School (PS). Others (OS), including Under-Graduation and Non-School Audience, compute only 2.5% of projects. The University's communication capacity justifies the concentration in ES. The University that offers the course interacts intensively with municipal schools in its region and has low interaction in state or federal schools.

Table 6 - Themes distributed by the school level.

Themes vs Level	Pre-School (PS)	Elementary School (ES)	Middle School (MS)	Young and Adults (YA)	High School (HS)	Others (OT)	Total
Environment	1,30%	21,30%	15,60%	1,30%	3,10%	1,30%	43,80%
Convergence	1,30%	9,40%	8,80%	0,60%	1,30%	0,00%	21,30%
Ice	0,00%	3,10%	2,50%	0,00%	1,30%	0,60%	7,50%
Life	2,50%	15,60%	3,80%	2,50%	2,50%	0,60%	27,50%
Total	5,00%	49,40%	30,60%	4,40%	8,10%	2,50%	100,00%

In its last column, Table 6 allows us to visualize the distribution of the projects by the four themes: Environment (43.8%), Convergence (21.3%), Ice (7.5%), and Life (27.5%). By crossing the numbers of the themes with school levels in which the projects were applied.

Environment was the most addressed theme in the projects (43.8%), with a greater concentration respectively at the ES levels (21.3% of 43.8%=48.6%) and MS (15.6% of 43.8=35.6%), totaling 84.2% of projects on Environment. Life, the second most discussed topic in the projects (27.5%), had a concentration of 56.7% at the ES level (15.6% of 27.5) and a similar distribution at the other levels. Convergence, the third (21.3%), was also concentrated in ES (9.4.3% of 21.3%=44.1%) and MS (8.8.6% of 21.3=41.3%) levels, totaling 85.4% of the projects on Convergence. The Ice theme, less represented at all levels (7.5%), does not appear in PS and YA.

The low frequency of the Ice theme may be related to the myth that Brazil is a verdant tropical country with inexhaustible wealth, far away and little affected by the coldest regions of the planet. This myth makes it difficult to understand the issue of global environmental changes (SIMÕES, 2013) and its consequent treatment in the classroom. The Convergence theme, also little discussed in the projects, possibly due to its absence in the Brazilian bibliography. The study of the history of Brazil in Antarctica and the understanding that the continent is part of the country's strategic environment are still incipient. Only in 2013, Antarctica was included in the concept of Strategic Environment (MATTOS, 2016), and only in 2018, it became the theme of the national curriculum through the BNCC (BRASIL, 2018), whose only appearance, in its 600 pages, it is in the context of skills in 8th grade learning Geography.

From the objectives and program content described in the projects, a list of keywords was extracted, revealing the main sub-themes addressed in the projects: fauna, flora, biodiversity, ecological awareness, global warming, global climate, anthropogenic action, environment, pollution, ecosystem, greenhouse effect, sustainability and others. Subthemes show the most relevant conceptual contents for the teachers participating in the course. These contents may occur due to their relevance or connection with the disciplines, the BNCC and curricular contents. The analysis shows the prevalence of Environment and Life themes and their subthemes, demonstrating interdisciplinarity of the Antarctic topics and the ease of their inclusion in the curriculum.

Table 6 shows the distribution of projects by discipline according to what was stated in the projects. When the projects declared two or more fields, for example, Geography and Biology or Mathematics, History and Language, the data were standardized to

Interdisciplinary. This standardization was carried out because it converges with an interdisciplinary approach inherent to the Antarctic themes and the course's proposals. As shown in Table 7, there is a prevalence of the Natural Sciences discipline (in PS, ES, MS, YA, OT). There is little dissemination of information about the relations between Antarctica and the social and human sciences. This data also shows that the course attracts more teachers in this area than in others, such as language, history, geography, etc. Those are paradigms that the course seeks to debate. From a procedural point of view, project-based pedagogy is conducive to an interdisciplinary approach. As evidenced, interdisciplinarity was considered in many projects, appearing in second place, with 28.7%. However, there is still a firm understanding that these studies are a whole part of the Natural Sciences, demonstrating the lack of knowledge about scientific research in Social Sciences and humanities applied in Antarctica.

Table 7 - Disciplines covered by the projects standardized data.

Disciplines	%
High School	
Biology	14,90%
Physics	2,00%
Chemistry	2,00%
Mathematics	2,00%
PS, ES, MS, YA, OT	
Language	3,00%
History	5,00%
Geography	21,80%
Interdisciplinary	9,90%
Natural Sciences	39,60%

When learning procedural content, teachers were expected to bring to the Polar Projects the methodologies developed in the AA? course, especially the project pedagogy, which places the student at the center of learning. However, the year 2020 was atypical. Due to the COVID-19 pandemic, teachers started to teach their classes using virtual classrooms or other online resources. As a result, teaching methodologies need to be revised, and the vast majority of professionals and schools were not prepared for remote teaching (DOTTA et al., 2021). For this reason, the analysis of procedural content learning

in the 2020 class was limited to analyzing the type of mediation conducted by teachers during the creation of Polar Projects.

Two categories emerged from the analyzed data: mediation by Active Methodologies and Traditional mediation. Traditional mediation includes proposals that include expository classes, with text reading, showing videos, and answering questionnaires or producing summary texts of the contents displayed. Active Methodologies require the student's participation in making knowledge by developing products (podcasts, social networks, blogs, videos, posters), learning by investigation, and participating in debates or conversation circles.

Data reveal 44% of teachers conducted their classes by traditional methods, while 56% mediated learning by Active Methodologies. Figure 3 presents the methodology distribution by school level. In high school, traditional methods prevailed, while there is a predominance of active methodologies at other levels. There is a high adoption rate of conventional methods, demonstrating that although the BNCC points to the need for active methods that promote the student's role (BRASIL, 2018), it is still difficult for teachers to use them.

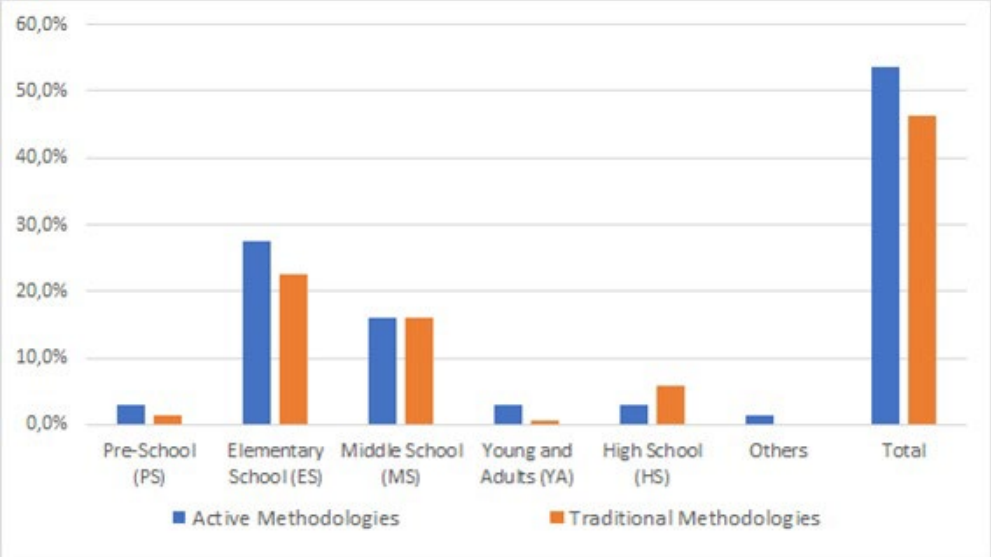

Figure 3 - Learning Mediation Methodologies according to school level.
Fonte: Elaboração própria.

Still, on procedural knowledge, it was expected to verify the increase in active methodologies. However, due to the context of the COVID-19 pandemic, in which teachers

were placed, without adequate preparation, into the world of technology mediated learning, our data and methodology adopted in this work are not sufficient to reveal the learning of these methodologies permeated by resources resulting in themes and questions for future work.

FINAL CONSIDERATIONS

In this work, we investigated the learning of conceptual and procedural contents primarily in order to verify if, during the course, the participants gained knowledge (i) about the continent and (ii) about how to mediate their students' learning about Antarctica in the context of school subjects.

Natural Sciences, Geography and Biology were the disciplines most favoured by the Antarctic approach. The environment was the theme most dealt with by the projects. Despite the importance of these disciplines and topic for antarctic knowledge, there is a significant gap for studies in human sciences and other topics as necessary as the environment.

We can conclude that the course led to the learning of basic conceptual knowledge about Antarctica. As we could see from the pre-and post-tests, the participants improved their knowledge about fundamental aspects of the present-day Antarctic, such as, for example, whale hunting practised in the region, the fact that it is the main reservoir of fresh water in the world, or no humans are living there permanently. We also see the course's contribution to correcting conceptual errors, such as the idea that the Orca is a whale.

The procedural learning promoted by the course can be observed in the appropriation of knowledge not covered by the course materials. We can also infer that the participants improved their knowledge of project pedagogy by being guided towards creating and implementing the polar projects. However, traditional methodologies continue to occupy space in most Projects, despite active methodologies being the majority. That suggests the need to create strategies in the course to drive the adoption of these methodologies.

The analyzes showed that AA? promoted the learning of different conceptual contents and contributed to the correction of misconceptions. The learning of procedural contents such as project-based pedagogy was also observed since the Polar Project's entire

creation and its implementation followed this methodology's guidance. The interdisciplinary approaches of the projects show the perception that the studies of the Antarctic continent cannot be compartmentalized into disciplines.

Therefore, project-based pedagogy is an alternative to insert Antarctica into the national curriculum. It favours the selection of themes according to the realities of the audiences (schools' identity, school levels, subjects, cultural contexts). Also, it promotes the interdisciplinary approach of Antarctic studies at any school level and any discipline.

Knowledge about the Continent and its influences on the Brazilian environment is not yet part of the mandatory minimum curriculum for Basic Education in Brazil. Thus, public school teachers have little or no information or didactic material to work in the classroom and are not adequately methodologically prepared and equipped to address the topic. The AA? course is an alternative to fill this gap by addressing the continent's essential issues that can be taken to different school levels in various disciplines. In this work, it was possible to promote diversified learnings about the continent and articulate those learnings in the school curriculum.

We concluded that it is possible to teach and learn about Antarctica in a non-content course. The project-based pedagogy is an appropriate methodology in training courses with a diverse audience and composed of teachers from various school levels.

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