International Journal of Advanced Engineering Research and Science (IJAERS)
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-8, Issue-2; Feb, 2021
Journal Home Page Available: https://ijaers.com/
Journal DOI: 10.22161/ijaers
Article DOI: https://dx.doi.org/10.22161/ijaers.82.31

# Potentially Meaningful Teaching Unit: Building Mathematical Problems Involving Power

Antonio Vanderlei dos Santos[1*], Marcelo Paulo Stracke[1], Carlos R. Brazzola[2], Mario O. Oliveira[2], Graciela Paz Meggiolaro Dal Molin[3]

[1]Mestrado do Programa de Pós-Graduação de Ensino Científico e Tecnológico, Universidade Regional Integrada do Alto Uruguai e das Missões (URI), Santo Ângelo, RS –Brasil.
[2]Facultad de Ingeniería, Universidad Nacional de Misiones – UNaM, J. M. de Rosas 325, Oberá, Misiones, Argentina
[3]Doutorado em Ensino de Ciências e Matemática. Universidade da Fronteira Sul (UFFS), Cerro Largo, RS, Brasil.

Received: 21 Oct 2020;
Received in revised form:
17 Jan 2021;
Accepted: 05 Feb 2021;
Available online: 25 Feb 2021



***Keywords*— Energy generators, Interdisciplinarity, Following teaching, PMTU.**

***Abstract*—** *In this work we aim to develop a Potentially Meaningful Teaching Unit (PMTU), capable of satisfying the interests and theories of meaningful learning. Using interdisciplinarity to make classes more attractive and a better transfer of information in order to form the concepts of teaching energy. Methodologically the research has a qualitative approach. Focused on the formation of the PMTU, before discussing the concepts of Physics and Mathematics, students are worked on a conceptual map produced by them, from the topic Energy Generators, making it possible for the teacher to observe the previous knowledge of each student regarding the theme. After all the content has been worked on, the proposal is to create a new conceptual map using the same theme of analysis, so that the teacher can observe whether the student has incorporated the fundamental concepts in his knowledge and for himself to evaluate his classes.*

## I. INTRODUCTION

Teaching methods aimed at improving classes and their efficiency in relation to students` learning have long been discussed. With this, it is important that the teacher defines strategies and techniques to be used in the teaching process, such as adapted approaches, which guides the resources to be used, and components that intermediate the relationship between teacher and student [1]. According to Almeida [2], students are having a lot of learning difficulties, a fact that is proven by the number of failures, mainly in the areas of mathematics and physics.

Our work justified by the current lack of teaching methodologies centered on meaningful learning, aimed at more efficient teaching, since the teacher finds it very difficult for the knowledge to have meaning [3]. The question that worries us to answer is: how should teachers proceed in order to discuss the concepts of energy generators using a Potentially Meaningful Teaching Unit (PMTU)? In formal book education, it is necessary to act generally through controlling strategies, which ends up generating discomfort between student and teacher, causing the demotivation of both.

Analyzing these facts, the objective of this research is to contribute to teaching, developing a didactic sequence capable of enabling the teacher to organize, evaluate and guide the learner in the teaching process. Since the PMTU bring this perspective, in meaningful critical learning the learner is the person who must critically capture the meanings of the contents of the teaching material. That is, it must have an intention to capture and internalize meanings accepted in the context of the teaching subject, but not as if they were unique and definitive [4].

As a basis we have interdisciplinarity, with mathematics being the main subject, and considering

physics, geography and others as secondary subjects, but no less important, so as to make classes more attractive, to seek greater participation of students during activities. According to Braβler [5], a teaching process is characterized by the combination of activities, where the teacher directs the teaching of the subjects, and the student learns progressively, carrying out interdisciplinary work. The concept of interdisciplinarity becomes clearer when considering the trivial fact that all knowledge maintains a permanent dialogue with other knowledge, which can be questioning, confirming, complementing, denying, expanding [6]. In this work, a methodological search of bibliographic revision type was sought, with a qualitative approach where the bibliographic research was made from the survey of theoretical references already analyzed, and published by written and electronic means. The main focus of the work is to develop and organize a didactic sequence, building mathematical problems when possible, with problem situations involving the types of energies, based on a Potentially Meaningful Teaching Unit (PMTU). We tried to develop this work by bringing together several subjects in an organized manner, involving calculations of mathematics, the types of energy generators in physics, facts worked on in geography and history, and reading and interpretation of Portuguese ... Therefore, it will be demonstrated how to elaborate a didactic sequence of the PMTU type, established by Moreira [6], structured in the form of meetings (Classes) in which the types of energy generation will be used as a generating theme. In all cases, this "integration module" or "integration work" is about proposing a complex work to the teacher, whether it is a problem situation that must be resolved or an original production that must be carried out [7]. Among the specific objectives we have, to investigate how to organize a didactic sequence based on a Potentially Meaningful Teaching Unit, to develop a contextualized Didactic Sequence proposal on the classification of types of energy involving mathematical problems and to present a way of working in an interdisciplinary way in basic school.

## II. THEORETICAL FRAMEWORK

The didactic sequence is a way of organizing a pedagogical work allowing to anticipate what will be studied in a given time, taking into account the students' prior knowledge and what they need to learn, with constant monitoring and follow-up by the teacher before the students through activities, evaluating the progress and the end of the work. It corresponds to a set of interconnected activities and objectives that are planned with the intention of reaching a certain didactic objective, organized around a specific content, aiming to help / assist the student to learn certain content and build knowledge, not only that the student memorizes the concepts [8]. As stated, didactic sequences are a very important tool for the construction of knowledge: When organizing the didactic sequence, the teacher may include different activities such as reading, individual or collective research, dialogued class, textual productions, practical classes, etc., because the sequence of activities aims to work on a specific content, a theme or a textual genre from the initial exploration until the formation of a concept, an idea, a practical elaboration, a written production [9]. For Pessoa [10] it is important to take into account some aspects for the elaboration of a Didactic Sequence, which are:

• Define the theme of the didactic sequence: the theme must be chosen according to what the teacher intends to work on and expects the student to be able to develop and learn during a certain period.

• What to take into account in the initial survey: always take into account what the student already knows and what he will learn during the didactic sequence.

• Establish contents and objectives: the contents worked on must be made very clear, and objectives must be established, keeping in mind what we want, which is intended for the student to know at the end of the sequence.

• How to link activities and objectives: think about strategies to reach the desired result, always observing what knowledge the student needs to have to move on to the next content. You can make a first proposal and analyze if you can advance content, or if you have to delay some activity for another time.

• Estimate the duration of the didactic sequence: this action must take into account the complexity of the content and not just the number of proposed tasks.

• Best way to organize the class: you should understand the didactic sequence and evaluate how the class will work best. Often working in a slightly larger group will allow the exchange of knowledge between the parties, but there may be difficulties if everyone does not cooperate.

• How to make activities more flexible: it is possible that in the class there is a student with special needs, he cannot be excluded or put to work separately, ways must be found so that he can participate together with colleagues in activities.

• If there is a need to change the plans during the application of the didactic sequence: when a didactic sequence is elaborated, it is necessary to analyze whether the students had a good base in previous classes, otherwise the planning must be changed to review contents that were not well designed, but will be needed during the next activity.

• How to assess what the class has learned: first, assess whether the student has moved from a smaller stage to one of greater knowledge. Taking into account the aspects already mentioned, an attempt will be made to develop a didactic sequence, capable of satisfying both the student's interest, showing a different way of learning mathematics, and that of the teacher, who may have a better use of his classes.

In schools, teachers often present certain content to students, they copy and try to memorize it for use during the test or for some proposed activity, and soon after they forget it. With PMTU, the student will be accompanied throughout the teaching process, the teacher will make sure that the student understands the content, and not just decorate to use it once, and then forget.

The use of PMTU for teaching different topics has been applied in several areas [11].

For Moreira [6], the information already mastered by the student is a significant factor that will influence his learning, having a certain mastery over a certain topic the student will be able to develop new learnings, facilitating the understanding of new concepts. Pessoa [10] believe that meaningful learning is based on the process where new information is developed and structured from knowledge that students already have. However, it is not enough for the teacher to be willing to develop a didactic sequence, based on a PMTU, the student must also be willing to develop his knowledge, being participatory, critical and questioning. Thus, you will have a better use of the content to be studied. A very important moment is found at the beginning of each meeting, as it is where the content of the previous class is resumed, taking time to clarify latent doubts, remembering that the content needs to be understood and not decorated by the student. The steps for the elaboration of a potentially significant Didactic Sequence were discussed, aiming to expand the possibilities of occurrence of Significant Learning in the development of activities. There are eight steps proposed by Moreira [6] for the elaboration of a PMTU:

1) Define the specific topic to be addressed, identifying its aspects to be studied as well as what content can be used.

2) Create / propose situations - discussion, questionnaire, concept map, mind map, problem situation, etc. with that the student will be able to show how much he already knows, and the teacher can work with the student to develop his knowledge from that.

3) Propose problem situations, with an introductory level taking into account what the student already knows, in these problem situations one can have the help of other types of materials such as games and software, making the class even more attractive, with greater participation of the student. student.

4. Once the initial situations are worked out, present the knowledge to be taught / learned, starting with more general, inclusive aspects, giving an initial view of the whole, of what is most important in the teaching unit, and then exemplifying, addressing specific aspects ; the teaching strategy can be, for example, a brief oral presentation followed by collaborative activity in small groups, which, in turn, should be followed by a presentation or discussion activity in a large group;

5. In continuity, resume the more general aspects of the content of the teaching unit, in a new presentation, but at a higher level of complexity in relation to the first presentation; problem situations must be proposed at increasing levels of complexity; give new examples, highlight similarities and differences in relation to situations and examples already worked on, that is, promote integrative reconciliation.

6. Concluding the unit, continue the process of progressive differentiation, returning to the most relevant characteristics of the content in question, but in an integrating perspective, that is, seeking integrative reconciliation, and in this part they must be proposed and worked on at higher levels of complexity in relation to previous situations; these situations must be resolved in collaborative activities and then presented and / or discussed in a large group, always with the mediation of the teacher;

7. The assessment of learning through PMTU must be made throughout its implementation, recording everything that can be considered evidence of significant learning of the content worked;

8. PMTU will only be considered successful if the assessment of student performance provides evidence of significant learning. Meaningful learning is progressive, the mastery of a conceptual field is progressive; therefore, the emphasis on evidence, not final behavior.

The evaluation methodology presented in point 7 of the proposal by Moreira [6] is also accepted by Training by Skills. They propose that “assessment must accompany the entire student's training process”, this being a fundamental principle of assessment by competences.

An interdisciplinary planning is when two or more disciplines relate their contents to deepen knowledge and bring dynamics to teaching. The relationship between disciplinary content is the basis for more interesting teaching, where one subject helps another. According to Braβler [5]: “interdiciplinarity does not dilute disciplines, on the contrary, it maintains its individuality. But it

integrates the disciplines from the understanding of the multiple causes or factors that intervene in the reality and works all the languages necessary for the constitution of knowledge, communication and negotiation of meanings and systematic registration of the results". This interdisciplinary process makes it possible to assist integration between students, and between them and teachers, and there may be an exchange and experiences between them, since in this type of activity the student will not develop his knowledge alone, but with other colleagues, with guidance of the teacher. It is known that teachers should always be studying, qualifying, looking for new ideas and methods, so that they can meet the needs of each type of student, an interdisciplinary educator will need even more study, according to Dube [12]: "an interdisciplinary educator does not it is built overnight. This demands from the educator initiative, a taste for risk, the ability to get out of pre-established schemes, personality maturation, in short, individualization".

According to the National Curriculum Parameters (PCN) [13]: Interdisciplinarity supposes an integrating axis, which can be the object of knowledge, a research project, an intervention plan. In this sense, it must start from the need felt by schools, teachers and students to explain, understand, intervene, change, predict, something that challenges an isolated discipline and attracts the attention of more than one eye, perhaps several. In this didactic sequence, we tried to work with interdisciplinarity, so that it will be possible to study certain content of mathematician, with the help of other disciplines such as physics, geography and Portuguese, interacting between them, but with the main focus on mathematics.

Within the Pedagogy of Integration, different schemes can be defined that represent modes or forms of integration. In this sense it proposes several ways, the first of which is Situations that mobilize knowledge acquired in various disciplines. In this way, the knowledge is developed in each discipline keeping strictly the specialization of the teachers [14]. Thus, the integration of the disciplines is only done when there is a work or integration module at the end of the year or also in complex problem situations that mobilize the knowledge of several disciplines.

For the development of the didactic sequence presented in this work, some types of energy generators were used, with the possibility of studying, understanding each one, and evaluating which type may be more useful and economical to be used in homes. The types of generators considered in this work are as follows [15, 16, 17]

• Mechanical Generator - this is the most common, efficient and varied among the types of generators. It can work through combustion, with fossil or organic fuels, external forces, such as wind or water, or heated fluids, whose steam generates the necessary mechanical movement for the activity. It can be a non-polluting generator using the wind, or highly polluting by burning fossil fuels.

• Chemical Generator - is capable of converting the energy generated in chemical reactions, into electrical energy usable in appliances. It stores the elements necessary for the reaction, which are usually activated by some external contact, such as the connection that completes the cycle between the positive and negative sides. This source is still little used as a generator of energy due to the high value that would need to be used to have a large scale of storage, however, the most used in this type of energy are batteries.

• Thermal Generator - uses thermal energy and converts it into electrical energy. It is capable of converting energy directly through heat, instead of converting the consequences of heat to another type of energy. In the case of many mechanical generators, burning fuel generates heat that turns a fluid into steam, which will drive the turbines and activate the generator. In the case of a thermal generator, the action does not go through the indirect process, using heat itself as a form of generation.

• Light Generator - uses light energy and converts it into electrical energy. This generator has no costs for the raw material, which is solar irradiation, and it is easy to implant solar panels, which can be placed even in small homes to produce energy during periods of irradiation. However, a material is needed to capture the solar radiation and convert it into usable electrical energy in common equipment. Generally, the material in question is silicon, which has a high market value, making the manufacture of this type of generator more expensive. • Wind Generator - uses wind energy and converts it into electrical energy. The kinetic energy of the wind is usually converted into mechanical energy by windmills and pinwheels, or into electrical energy by wind turbines (or aero generators). 2.4. Content In this didactic sequence, an interdisciplinary work was presented with mathematics as the guiding discipline, physics, geography and Portuguese as assistants in the development of questions. Mathematical problems involving the contents of: Scientific Notation; Graphics; Percentage and Exponential Function.

## III. METHODOLOGY

We classified our research as a literature review type, with a qualitative approach. The methodological

definitions of scientific works are somewhat divergent at the present time. In this work, we use the classic classification of research described by Jakeman [14]. As for nature, we carry out applied research because we are interested in practical results. In relation to objects, we have an exploratory research because we are exploring a universe of data to draw conclusions about them. As for the way to approach the problem, the research can be classified as qualitative, so that the research considers that there is a dynamic relationship between the real world and the subject, that is, an inseparable link between the objective world and the subjectivity of the subject which cannot be translated into just numbers but an apprentice with high relevance in meaningful learning.

The bibliographic research was made from the survey of theoretical references already analyzed, and published by written and electronic means. Didactic materials and websites that bring knowledge about: energy generators, Scientific Notation, Graphics, Percentage, Exponential Function, Logarithmic Function were analyzed, as well as mathematical problems related to the students' daily lives, with the purpose of elaborating a Didactic Sequence. This Didactic Sequence was elaborated in the 1st (first) semester of 2018, without being tested in the classroom. The Didactic Sequence, was elaborated seeking to satisfy the interest of students of the 1st year of High School of the basic school, mainly because they are students with more experience of life, and thus the content will be useful in the activities carried out in their day-to-day activities. day. The data were collected through research and reading in textbooks, and articles published on the internet using the books recommended in the PNLD (National Textbook Program) [19]. To search for the articles, Google academic was consulted, using the keywords; Potentially Meaningful Teaching Unit, Didactic Sequence, Energy Generators, Scientific Notation, Graphs, Percentage, Exponential Function, Logarithmic Function.

After the articles and data were collected, analyzed and studied, a Didactic Sequence was developed based on a Potentially Meaningful Teaching Unit (PMTU). The didactic sequences are “a set of ordered, structured and articulated activities for the achievement of certain educational objectives, which have a beginning and an end, known both by teachers and by students” [16]. Thus, we will always try to follow the planning without skipping steps, trying to solve the difficulties using the knowledge that, a priori, the students already have on the topic to be studied. Each phase of the project will be organized in the form of PMTU, seeking to build meaningful learning, thus the student will be able to explain and apply the knowledge acquired to new situations. The PMTU according to Neto [4], “They are theoretically grounded teaching sequences, focused on meaningful, non-mechanical learning, which can stimulate applied research in teaching”.

## IV. RESULTS

We will present below an explanatory table with the steps and content to be developed in each stage of the PMTU according to the theoretical framework discussed.

*Table 1. Didactic sequence.*

| Period | Content | Objective Strategies | Resource used |
|---|---|---|---|
| Lesson I<br>2 hour / class | Cientific notation, Graphics, Percentag, Power generators | That the student is able to demonstrate his previous knowledge about the contents to be studied. | Muc, Expository class dialogued, Examples. |
| Lesson II<br>2 hour / class | Cientific notation, Graphics, Percentag, Power generators | That the student is able to read and interpret the text by performing the activities | Muc, Expository class dialogued, Together with students discuss over the text, Exercises, Exercise correction. |
| Lesson III<br>2 hour / class | Graphics, Percentag, Power generator, Function Exponential | That the student is able to watch the video and debate, immediately after, the content of exponential function started to be worked | Muc, Expository class dialogued, Video about generators energy, Introduction to scientific notation content, examples, Exercises. |
| Lesson IV<br>2 hour / class | Exponential fucntion and systems | That the student is able to build graphs of the exponential function. | Muc, Dialogue lecture,<br>In this class the students worked |

| | | | |
|---|---|---|---|
| | | | with the GeoGebra program in the computer lab.<br>Exercises and correction. |
| Lesson V<br>2 hour / class | Exponential function:<br>•Application,<br>• Euler's number | That the student is able to understand where the exponential function and the Euler number apply | Muc, Expository class dialogued, Examples, Exercises and correction. |
| Lesson VI<br>2 hour / class | Exponential equation and systems | That the student is able to work the systems. | Muc, Expository class dialogued, Examples, Exercises and correction |
| Lesson VII<br>2 hour / class | Exponential inequality. | That the student is able to work with exponential inequality and check if the functions are increasing or decreasing. | Muc, Expository class dialogued, Examples, Exercises and correction |
| Lesson VIII<br>2 hour / class | Graphics, Percentage, Power generators, Exponential function | That students in groups can work each group with a type of energy generator, and create a letter. | Muc, Expository class dialogued, Students will be divided into groups so that they can work with the power generators, to present to colleagues. |

*Table 2. Potentially Meaningful Teaching Unit.*

| **Period** | **Potentially Significant Teaching Unit (PSTU)** | **Evaluation Indicators** |
|---|---|---|
| Lesson I<br>2 hour / class | Initial situation | Evaluation of students' prior knowledge through initial concept maps.<br>Evaluation of questions under the study topic. |
| Lesson II<br>2 hour / class | Problem situations initials | Evaluation of a summary made by the student. |
| Lesson III<br>2 hour / class | Deepening Knowledge | Evaluation of the review on the use of concepts in the student's daily life. |
| Lesson IV<br>2 hour / class | Deepening Knowledge | Evaluation of concept maps developed by students at and presented at the end of class to other colleagues. |
| Lesson V<br>2 hour / class | Deepening Knowledge | Evaluation of the use of concepts in didactic applications. |
| Lesson VI<br>2 hour / class | Deepening Knowledge | Evaluation of questions under the study topic.<br>Evaluation of initial concept maps. |
| Lesson VII<br>2 hour / class | Deepening Knowledge | Evaluation of questions under the study topic.<br>Evaluation of initial concept maps. |
| Lesson VIII<br>2 hour / class | final situation | Evaluation of the use of concepts in daily applications |

## V. CONCLUSION

During the development of this Potentially Significant Teaching Unit, an attempt was made to work in an interdisciplinary way, using whenever possible situations of the student's daily life involving energy generation, so that, when applied, it is possible to keep the student focused and participating in the classes. , always leading the student to investigate the content.

This researched theme was necessary to realize that a math class can be much more than a simple class, where the student copies the book, solves the proposed questions, studies for proof and the next day he forgot, since many Sometimes he ends up asking the teacher, where and when he will occupy certain content in his life.

Although this Potentially Meaningful Teaching Unit has not been applied at this time, it is perceived that it is necessary and is extremely important for the teacher to be able to teach a good class, and that the student evolves during the classes from a mere spectator to a student capable of interpreting, investigating and transmitting what he learned during classes.

Thus, we conclude that we can make math and physics classes much more attractive by looking for new ways to work, using subjects from other areas to introduce content, interacting between disciplines, not forgetting the mathematical focus that is the main guiding discipline of our PMTU.

## ACKNOWLEDGEMENTS

This work has been carried out thanks to the support of the URI- Santo ângelo and CNPq. This project was funded by ANPCyT. The authors would like to thank Samuel Jackson for his collaboration in preparing this article.

## REFERENCES

[1] Veiga, I. P. A. (2006) Projeto político-pedagógico da escola. Campinas: Papirus Editora.

[2] Almeida, F. J. (2001). Projeto Nave. Educação a distância. Formação de professores em ambientes virtuais e colaborativos de aprendizagem. São Paulo.

[3] Ausubel, D. P. (2003) Aquisição e retenção de conhecimentos: uma perspectiva cognitiva. Lisboa: Plátano.

[4] Neto, M. J., Aguillera, A. G. F. (2021). ESTADO DA ARTE: APRENDIZAGEM BASEADA EM PROJETOS E O ENSINO DA FÍSICA vol. 9 n. 1: Janeiro a abril - Ahead of Print (AOP).

[5] Braβler, M. (2020) The Role of Interdisciplinarity in Bringing PBL to traditional Universities: Opportunities and Challenges on the Organizational, Team and Individual Level. The Interdisciplinary Journal of Problem- Based Learning (ISSN 1541-5015), 14(2), 1-14. https://doi.org/10.14434/ijpbl.v14i2.28799.

[6] Moreira, M. A. (2017). Unidades de Ensino Potencialmente Significativas – UEPS*. Vol. 6. https://www.if.ufrgs.br/~moreira/UEPSport.pdf.

[7] Meireles, E. (2014). Como organizar sequências didáticas. Nova Escola, 2014. https://novaescola.org.br/conteudo/1493/como-organizarsequencias-didaticas.

[8] Calácia, D. (2017). O que é uma sequência didática? http://naescola.eduqa.me/registros/o-que-e-uma-sequencia-didatica.

[9] Nuncio, A. P. (2017). Unidades de Ensino Potencialmente Significativas para o Corpo Humano no Ensino de Ciências. Scientia cum Industria, V.4, n.4, 212. http://www.ucs.br/etc/revistas/index.php/scientiacumindustria/article/viewFile/4902/pd f.

[10] Pessoa, A. C. G. (2017) Sequência Didática. Termos de Alfabetização, Leitura e Escrita para educadores. ISBN: 978-85-8007-079-8. http://ceale.fae.ufmg.br/app/webroot/glossarioceale/verbetes/sequencia-didatica.

[11] de Mello, L. A. (2021). Repositório Institucional da Universidade Federal de Sergipe. USE OF CONCEPT MAPS AS ALGORITHMIC LANGUAGE TO BUILD POTENTIALLY SIGNIFICANT TEACHING UNITS OF MATHEMATICAL OR SCIENTIFIC MODELS. https://ri.ufs.br/bitstream/riufs/13872/2/UseConceptMapsAlgorithmicLanguage.pdf.

[12] Dube, B. (2021). Why cross and mix disciplines and methodologies?: Multiple meanings of Interdisciplinarity and pluralism in ecological economics. Ecological Economics. Vol. 179. https://doi.org/10.1016/j.ecolecon.2020.106827.

[13] Silva, C.N., Mendes, M. A. F., Carvalho, M. M., Stroppa, G. M. (2021). Paleontologia e ensino básico: análise dos Parâmetros Curriculares Nacionais e dos livros didáticos em Juiz de Fora, MG, Brasil. Vol. 24 No. 1 https://doi.org/10.4072/rbp.2021.1.05.

[14] Jakeman, Rick C., Henderson, Markesha M.; Howard, Lionel C. (2017). Pedagogia reflexiva: a integração da metodologia e do conteúdo programático em um curso de graduação. Ensino no Ensino Superior. Vol. 22, n2, p 207-221. https://eric.ed.gov/?q=%22Pedagogy+of+Integration%22&ff1=dtySince_2017&id=EJ1123492.

[15] Portal da Energia. (2017). Tipos de Geradores de Energia: Conheça. Disponível em: http://portaldaenergia.com/tipos-de-geradores-de-energia-conhecaQUEIROZ, Maria Neuza Almeida. (2011). Uma Proposta Didática para o Ensino de Geradores de Energia Elétrica: subsídios ao CBC mineiro. 2011. http://www1.pucminas.br/imagedb/documento/DOC_DSC_NOME_ARQUI20130924111535.pdf.

[16] Roma, M. (2011) Eletrotécnica Básica: Geradores Químicos.http://profmarylleneroma.blogspot.com.br/2011/05/eletrotecnica-basica-geradores-quimicos.html.

[17] Turrioni. B., Melo, C. H. P. (2012). METODOLOGI A DE PESQUISA EM ENGENH ARI A DE PRODUÇÃO-Estratégias, métodos e técnicas para condução de pesquisas quantitativas e qualitativas. Programa de Pós Graduação em Engenharia da Produção da Universidade Federal de Itajubá – UNIFEI.

[18] Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal de Itajubá - UNIFEI

[19] Brasil (2017). Ministério da Educação. Fundo Nacional de Desenvolvimento da Educação-FNDE. https://www.fnde.gov.br/programas/programas-do-livro.

[20] Zamberlan, J. F., Guimarães, G. E., Masutti, G. G., dos Santos Salazar R. F. (2018). Practical based learning pbl for academic technological and scientific education in engineering courses case study. International Journal of Advanced Engineering Research and Science. (ISSN : 2349-6495 (P) | 2456-1908 (O)**),** 6(9), 131-134. http://dx.doi.org/10.22161/ijaers.5.6.22.