



## The ABP Strategy Applied to the Learning of Renewable Energy Sources with Synchronous and Asynchronous Operability

---

Jessica Guevara-Sáenz de Viteri, Margarita Naranjo Valencia, Emérita Delgado-Plaza and Juan Peralta-Jaramillo

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

January 11, 2021

# The ABP Strategy applied to the learning of Renewable Energy Sources with synchronous and asynchronous operability.

Jéssica Guevara Sáenz de Viteri 1, 2; Margarita Naranjo Valencia 2; Emérita Delgado-Plaza 1; Juan Peralta Jaramillo 1.

1. *Escuela Superior Politécnica del Litoral-Facultad de Ingeniería en Mecánica y Ciencias de la Producción, Centro de Desarrollo Tecnológico Sustentable.* [jgueva@espol.edu.ec](mailto:jgueva@espol.edu.ec), [eadelgad@espol.edu.ec](mailto:eadelgad@espol.edu.ec), [jperal@espol.edu.ec](mailto:jperal@espol.edu.ec)
2. *Universidad de Guayaquil- Facultad de Filosofía, Letras y Ciencias de la Educación.* [margarita.naranjov@ug.edu.ec](mailto:margarita.naranjov@ug.edu.ec)

**Abstract--** *ABP strategy is applied in learning renewable energy sources using: repetition, grouping, inference, deduction, mental investigation, recognition of technical terms, allowing the value processing of use as a participatory discipline in environmental care. The e-book as a means of consultation in synchronic and asynchronous times between teachers and students proposes cultural change and awareness in institutions of higher education; generating support texts with collaborative writing, for group interaction, receiving inputs to improve the proposed content, the methodological strategy is used as the driving axis in the process-learning.*

**Palabras claves:**

Problem based learning strategy, collaborative writing platform, learning process.

## I. INTRODUCTION

The educational reforms of the last decades in the region place the curriculum as an element of great importance, which concerns several aspects of design. Curricular transformations that did not enter the classrooms, but as multiple mutations distant from the intentions with which they were raised at the central levels of the education system.

Nowadays the training institutions of our region are going through a particular situation of evaluations and rethinking of their reforms in order to incorporate innovative approaches that

allow responding to current challenges in education, without neglecting questions about what to teach? Why do it? and how to do it? [7]

Higher education institutions (IES) must respond to these socio-educational changes and, for this purpose, improvement activities in the process-learning are carried out, taking into account the commitment to generate knowledge in higher-level programs, which will be projected in the professional field. Therefore, students must have a set of skills, abilities and competencies, which will allow them to achieve synergy with a critical social sense in order to find solutions to social problems linked to participative strategies in virtual classroom of quality learning environments [15].

The transformations of the globalized context, cutting-edge technology pressures and encourages new challenges in curricular policies with respect to learning standards and their assessment harmonized with the role of teachers; and its diversity in all dimensions: personal, gender, and cultural. [6] With these considerations and taking into account the orientations of the Regional Education Project for Latin America and the Caribbean of Unesco

The Latin American initiative of textbooks (e-book), is born to cover a need in the institutions of superior level, with respect to: little accessibility of physical texts for high costs of works, theoretical contexts that are not adapted the reality of Latin American, recent versions that are not available in the local language, among others. This situation has generated motivation among teachers and researchers of the IES for the writing of supporting texts that contribute to the training tasks of undergraduate students.

Teachers present timely text proposals (e-book) about topics related to the subjects they dictate, incorporating methodologies and strategies that make the learning process of their students viable. This being the case of the text (e-book) entitled "Introduction to the Study of Renewable Energy Sources".

The curriculum is conceived as a social historical construction, expressed in general systems of characterization and assessment of knowledge, which in turn take the form of administrative-academic regulations in the centers combining experience with learning in the classrooms according to the subject that is formed.

## II COLLABORATIVE WORK AND ITS OPERATIONS USING THE CMC

The ABP favors the extra-clinical interaction evidencing particular traits of life trajectories (social, training, disciplinary and professional ascriptions) of the subjects and relevance in specific socio-cultural contexts. On the other hand the skills of problem-based learning (ABP), [4] are part of the constructivist method, enabling the subject to think critically, developing skills to: solve situations, make decisions, adapt to changes and teamwork, possess thinking logical- reflexive and formal with an emphasis on ethics. [2]

This strategy works as an interface in the learning process supported by new communication technologies between teachers and students. Nowadays the teacher must develop in virtual environments that facilitate learning to students. [1]

The CMC means computer-mediated communication, activated in the curricular planning for the development of face-to-face and autonomous activities in two stages: synchronous and asynchronous. The first, promotes the development of activities in real time and immediately; and the second is done in ample times to plan the language and make fewer mistakes. In this way the synergy (theoretical-practical) is generated in which knowledge is taught and applied jointly. As shown in Figure No. 1

The Latin Project, with this initiative, aims to promote the development of support texts at a Latin American level to facilitate the learning process by combining the use of freely accessible information sources for the university community. The integration of knowledge occurs through the awareness, use and optimization of resources in activities specific to training, which ultimately involved the student as a professional. [18]

## III METHODOLOGY

Writing groups were created (text ebook), with which revisions were made and changes were established in a free software platform until completing the test phase of the text content to be implemented in the curriculum of higher education courses. In Figure No.2 we appreciate the mentioned process.

### A. Acceptance and Approach of the contents by chapters

The proposal is based on a base material with notes, definitions and applied exercises that will introduce topics related to the use of energy sources incorporating participatory graphic applications relating resources: solar, water, wind, biomass with the local productivity matrix. [5]

### B. Articulation of objectives according to the curriculum

The strategic methodological employment of the PBL allows reaching the proposed achievements in the knowledge of the student subject (reader), strengthening the teaching process between the teacher and student. [19]

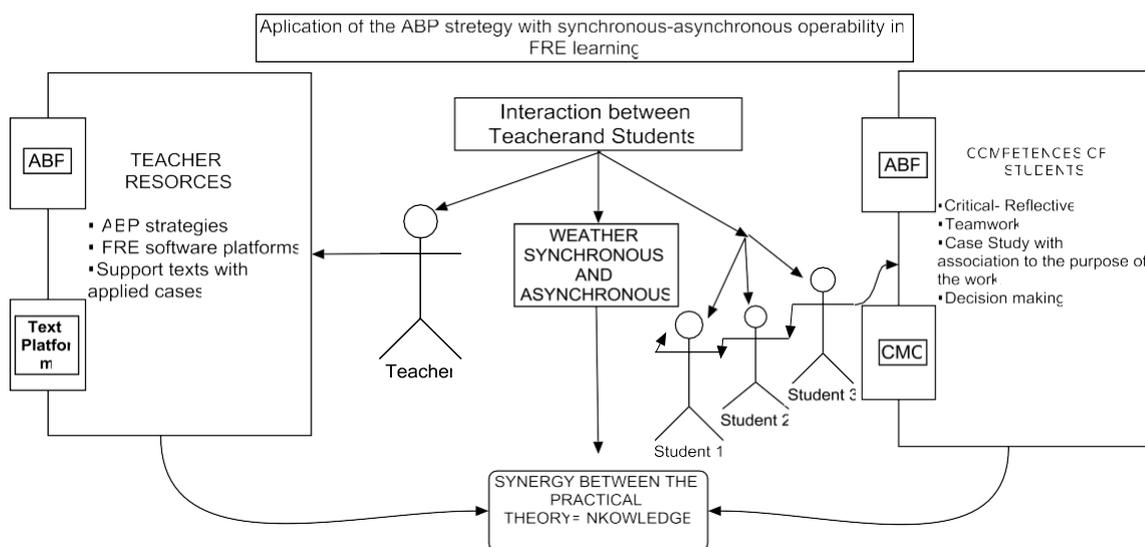


Fig. 1. Synergy Theoric- Practice

The objectives below are articulated based on the application of the case studies referring to the content of the chapters, where knowledge is conceived under the models: When the subject interacts with the object of knowledge (Piaget). When this is done in interaction with others (Vygotsky). When it is significant for the subject (Ausubel).<sup>[2]</sup>

### C. Elaboration of the draft and validation

The e-book seeks to achieve the organization of concepts and propositions in the cognitive structure of the student, evidencing the information lodged in his mental scheme and his associativity during the development of activities. The student becomes aware of their prior knowledge before interacting with the teacher.<sup>[19]</sup>

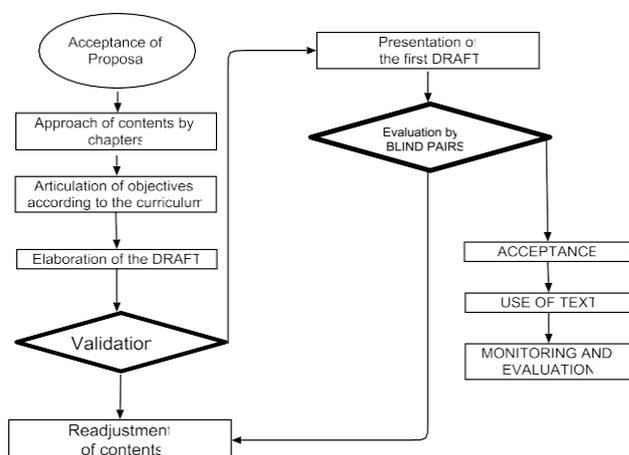


Fig. 2. Methodological scheme

Figure 3 shows an example of how the cognitive structural scheme of the types of energy source are related to new elements and these in turn with the actions established in the objectives.<sup>[3]</sup> Achieving interaction in concrete and significant situations, stimulating knowledge with the conceptual, procedural and attitudinal.<sup>[20]</sup><sup>[11]</sup>

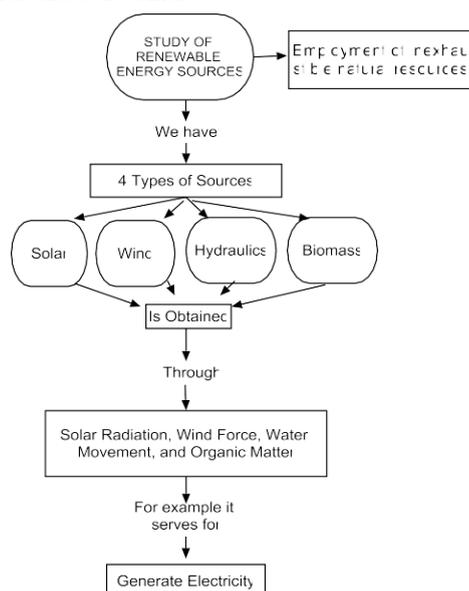


Fig N° 3 Cognitive structure of the subject

### D. Readjustment of contents

The readjustments of the contents of the ebook are produced through the linking of reviewers on the platform who determine whether the theoretical support of the contents presented in the chapters, the graphics used are related to each other, or to the proposed objectives. Another advantage of this platform is the visibility of the number of interactions with readers.

### E. Evaluation by pairs

During the process of validation and final approval of the e-book for publication, a peer review by experts is established according to the themes, where they consider aspects such as: relevance, current status, and number of local cases exposed, originality, and scientific content according to the discipline, quality of the illustrative content and use of updated bibliography.

### F. Acceptance and Use of the E-book Text

The text proposed e-book is non-commercial, allowing teachers to use it as a support tool practicing the use of the CMC concept in the academic activities of the various courses related to the theme of the use of renewable energy sources as well as the use of resources natural with national and international projections in Latin America.

The use of the CMC incorporates the system of tracking the scope of achievements, skills and competencies during the student learning process through the platform and its adaptability of the problem-based learning methodology (PBL), which has allowed the development of autonomous, meaningful and contextualized learning.<sup>[10]</sup><sup>[12]</sup>

The use of CMC couples the transmission of knowledge between the teacher and the students who develop cognitive skills specific to the training aligned with professional performance.<sup>[7]</sup>

### G. Monitoring and evaluation

Surveys were developed to the students regarding: the application of the e-book, contents, use of methodology applied in the case studies, the use of the text e-book as support material in the classroom and field activities.

For the methodological operationalization of the contents of the e-book text, the ABP strategy was used, linking the cognitive scheme of the e-book structure with graphs, diagrams, figures and cases associated with the use of renewable energy sources, introducing legal support, scientific and investigative in eight chapters.<sup>[9]</sup> Catapulting the student from level zero towards basic knowledge levels in the discernment of the socio-productive use of Renewable Energy Sources combined with environmental care.<sup>[8]</sup>

#### IV RESULTS AND DISCUSSION

In Table 1, the results are shown from the SURVEY made after the application of the e-book material in the Ecology and Environmental Education courses, as well as the Energy Conversion Systems in ESPOL.

The survey was applied in a sample of 230 students who studied the subjects of Ecology and Environmental Education, as well as the Energy Conversion Systems, which correspond to a higher education level and are completing the curriculum of engineering careers, while the subject of Energy Conversion System belongs to the Mechanical Engineering degree.

TABLE I  
RESULTS OF FREQUENCIES ON PROMOTION OF LEARNING OF RENEWABLE ENERGY SOURCES

¿ You think that the study case of the "productive matrix of Ecuador" developed in the ebook, it contributed to the improvement of the learning of the energy sources in the participants?		
Alternatives	Frequency	Porcentaje
Significantly	106	46
Moderately significant	85	37
Little significant	15	7
No Significantly	24	10
TOTAL	230	100

Source: Students of Ecology and Environmental Education and Conversion Systems ESPOL 2017

In summary, 80% of those consulted considered that the incorporation of the case study on the productive matrix of Ecuador, contributed significantly to learning and can incorporate the material covered in the e-book during the regular course activities to strengthen the process of learning about the basic principles of renewable energy sources, as well as the intrinsic value of use and alternatives. Course that must be aligned with the activities proposed in the e-book

Another relevant aspect they found was the association of the topic of energy efficiency with respect to the case studies involving all Ecuadorian anthropological activities according to the basic and sumptuary needs of energy. This was complicated to explain before reviewing the first chapters of the e-book.

An additional strategy to carry out the successful implementation of the e-book is "The method of developing classroom projects from the material", since it allows the theory to land in concrete situations that stimulate "knowledge", "know-how" and "Know how to be", that is, the conceptual, the procedural and the attitudinal

The e-book developed skills linked to deep thinking, know-how and attitudes. <sup>[16]; [22]</sup> The readers transcended conceptually and made connections with the real world. <sup>[13]</sup> See Table II and Figure 4 with response frequency results:

1 Knowledge of the current landscape of renewable energy sources and the basic principles of application.

2 Ability to interpret the demand and supply of energy in an energization system.

3 Ability to evaluate the environmental and socioeconomic aspects of the use of renewable energy sources.

4 Basic knowledge of energy transformation processes

5 Ability to identify and interpret information in the field of renewable energy sources.

6 Decision making in aspects related to renewable energy sources. <sup>[21]</sup>

TABLE II  
RESULTS OF RESPONSE FREQUENCIES IN DEVELOPMENT OF SKILLS

Alternatives	Frequency
Knowledge of the current panorama and basic principles of application	178
Ability to interpret the demand and supply of energy in an energization system	200
Basic knowledge of energy transformation processes	230
Ability to identify and interpret information in the field	189
Decision making in related aspects	125
Ability to evaluate the energetic aspects	175

Source: Students of Ecology and Environmental Education and Conversion Systems ESPOL 2017

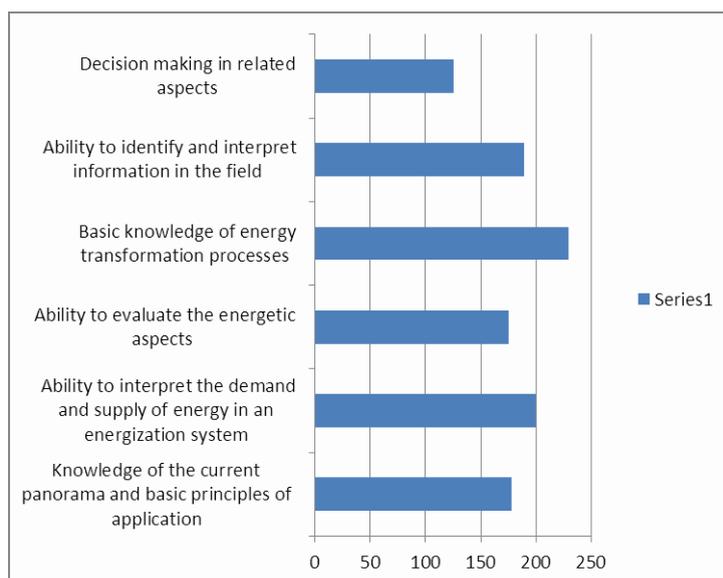


Fig N° 4 Results of response frequencies in development of skills

Source: Students of Ecology and Environmental Education and Conversion Systems ESPOL 2017

#### V STATISTIC ANALYSIS.

The statistical test T for related samples was applied due to a comparative analysis of means in the samples taken BEFORE and AFTER the Implementation of the e-book Renewable Energy Sources, using scales valued for a factor linked to the synchronic theory and asynchronous.

This factor considered aspects such as: permanent communication through chat with the teacher, tasks planned by deadline with case studies linked to the local productive matrix online and the collaborative process between online teachers

It is appreciated that the sample is a normal distribution because the mean is greater than 0.05. In the table of the Kolmogorov tests, it is evident that the statistic of Before is 0.196 and After is 0.216.

TABLE III  
RESULTS OF NORMALITY TESTS

Normality Tests						
Kolmogorov-Smirnov			Shapiro-Wilk			
Statistical	gl	Sig	Statistical	gl	Sig	
Before	.196	45	.00	.814	45	.00
After	.216	45	.00	.762	45	.00

Significance Correction Lilliefors

The trend of the distribution, showed that the tendency of the dispersion of the points of the curve decreased after the e-book was applied, which means that it is adjusted to a normal distribution implying the success of the implementation of the e-book, however, the normality test is not as strong as the comparison of means for this case.

## VI. CONCLUSIONS

The application of the ABP technique combined with the use of open access platforms reinforce the teaching-learning process, as well as participation in collaborative activities through tutorial groups.

The use of the platform combined with the logical design of the content of the work allows fostering the development of skills through the search, analysis of information, and decision making inherent in the reality of the environment. In this case, the local productive matrix vs. the use of renewable energy sources.

You can appreciate the development of the heuristic capacity that describes the art of computing in the use of the platform conjugated with the fundamentals of the use of energy, solving problems through creativity.

It is demonstrated with the survey before and after the implementation of the e-book, that the ABP strategy through the use of cases allowed to acquire in the reader the competences of: Basic knowledge of the processes of energy transformation; followed by the development of the ability to interpret the demand and supply of energy in an energization system that is needed in the context of current demands.

The development of these competences generates an important synergy to visualize professional studies in the area of Renewable Sources of Energy.

The e-book responds to a requirement established by UNESCO in the area of Sciences; subarea Number 4: "subjects related to earth science, atmospheric sciences included in climate research, marine sciences, vulcanology, paleontology and others" [14].

The application of the e-book Writing Platform, fits into the evaluative practice, specifically as a mental construct conducive to the pedagogical exercise and conceptual affirmations, allowing the active participation of the teaching authors during the process of professional training improvement; in real times with its respective self-evaluation, coevaluation and evaluation by technical pairs.

The users of the text writing platform develop value judgments due to the active participation in the construction of teaching-learning methods, awakening the interest to learn the use of new computer tools of a collaborative nature; sharing experiences in various stages and the subsequent rationalization on the part of the students. Covering from the elemental to the complex.

The aspects considered such as: permanent communication through chat with the teacher, tasks planned by deadline with case studies linked to the local productive matrix online and the collaborative process between online teachers; they correspond to the use of the CMC whose purpose is the coverage of autonomous activities.

The e-book implementation pilot was developed during the courses of: Energy Conversion Systems of the Faculty of Mechanical Engineering and Production Sciences; and in the Ecology and Environmental Education, which are part of the Engineering curriculum at the Polytechnic School of the Litoral, being widely accepted by students.

## ACKNOWLEDGMENTS

The e-book was funded by the Project Latin Project executed in ESPOL- Polytechnic School of the Litoral through the CTI - Center of Information Technology between 2013 and 2014 and the co-authors wish to express their gratitude to: Eng. Gladys Carrillo, Diagramming of texts; Eng. Xavier Ochoa, PhD. André Ortega, Eng. Naara Pérez and Margarita Ortiz MSc for the logistical support by CTI-ESPOL.

To the Ministry Biblic House for the logistical support in the selection and design of figures through Lcdo. Edgar Rodríguez, Lcda. Judith Rodríguez and Eng. Freddy Flores.

Finally, a recognition to the Senior co- author, Eng. Alfredo Barriga Rivera PhD (+); who wrote the notes bases of classes on which were elaborated some chapters of the work.

## REFERENCES

- [1] Ángel, Zabalza Miguel, “Competencias docentes del profesorado universitario, calidad y desarrollo profesional”. Madrid – España. pp. 36. , 2007
- [2] Bermudez, Sarguera, Rogelio, Rodríguez Rebastillo, Marisela. “ Teoría y metodología del aprendizaje”, Chapingo, MX: Universidad Autónoma Chapingo. 2000. 118 p. 2000
- [3] Cedder Fundación ,” Gestión de las Energías Renovables, Perspectivas de Futuro”, 6ª edición, Madrid España, , CIEMAT, 2007
- [4] Correa, Avilés César,”Aprendizaje Basado en Problemas en la Educación Superior”, Medellín – Colombia. pp. 116, 2009
- [5] CONELEC, Plan Nacional de Electrificación., Quito, Febrero 2013.
- [6] Diaz, Alcaraz Francisco,”Didáctica y currículo, un enfoque constructivista”, Cuenca – Ecuador. pp. 77, 2002
- [7] Diaz Mario de Miguel “ Metodologías de enseñanza y aprendizaje para el desarrollo de competencias. Orientaciones para el profesorado universitario ante el Espacio Europeo de Educación Superior”. Universidad de Murcia, España pp 207 – 210, 2006
- [8] Duffie, John A, William A. Beckman , Sandorf A. Klein; “ Solar heating design by the charts method”; Editorial Wiley corp.; New York; 2011.
- [9] BUN-CA Compendio de estudios de caso de proyectos demostrativos de energía renovable a pequeña escala en América Central /Biomass Users Network . -1 ed. - San José, C.R. : Biomass Users Network, 2011
- [10] Escribano Alicia, Del Valle Ángela , “El Aprendizaje Basado en Problemas una propuesta metodológica en Educación Superior”, Narcea, S.A. de Ediciones, España pp. 1- 491, 2008
- [11] Espinoza J., “Renewable Energy for Rural Electrification in Ecuador: Application to remotes areas, Project, Master, Program in Energy and Environment”, OLADE / U of Calgary 2012.
- [12] Gavotto, Nogales Omar, “La evaluación de competencias educativas”, Guadalajara – México. pp 34.,2012
- [13] Guillamet, Lloveras Ana, “Influencia del Aprendizaje Basado en Problemas en la Práctica Profesional”, Barcelona – España. pp 169, 2012
- [14] Luque A.”Handbook of Photovoltaic Science and Engineering, Edited by Antonio Luque Instituto de Energía Solar”, Universidad Politécnica de Madrid, Spain, 2012
- [15] Marco, Stiefel Berta, “Competencias Básicas, hacia un nuevo paradigma educativo”, Madrid – España. pp 46, 2010
- [16] Martínez, José. “Energía Geotérmica: Como generar masivamente Electricidad calor y frío con la energía de la tierra.” Unión Española de geotermia . Primera edición España, 2013.
- [17] Mendez . Rafael Cuervo. Energía Solar Térmica . ECA Instituto de Ecnología y Formación. Editorial FC. España, 2014
- [18] Santiago J. Sánchez Miño, “ Energías Renovables, Conceptos y Aplicaciones”, pp 50-66, 2013
- [19] Tobón Sergio, “Estrategias didácticas para la formación de competencias”, Bogotá – Colombia. pp 26, 2010
- [20] Villardón, Gallego Lourdes, “Planificar desde competencias para promover el aprendizaje”, Buenos Aires– Argentina. pp, 2010
- [21] Valeriano, Ruiz, Manuel A. Silva.” Energías renovables, 5º de ingeniería industrial. Sevilla”, Escuela Superior de Ingenieros Universidad de Sevilla, 2011
- [22] [http://www.europa.eu.int/comm/energy/res/legislation/electricity\\_en.htm](http://www.europa.eu.int/comm/energy/res/legislation/electricity_en.htm),