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E-Pedagogy Competencies and Abilities of Teachers, Requested for Running Electrical and Computer Engineering Education Programs

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ABSTRACT
The paper is about E-Pedagogy Competences and Abilities of Teachers, Requested for Running Electrical and Computer Engineering Education Programs. The role of the didactic scenario in blended teaching and learning is described. Learning path importance in Interactive courseware is discussed. The paper presents: how to prepare STEM teachers and students to use blended learning environments; BTL course components and activities for electrical and computer engineering education; and an example of application of educational objectives of *Bloom* and *Anderson* & *Krathwohl* taxonomy. In fact the paper is a Synthesis and a continuation of previous papers [1]-[7] most of these papers are available on the internet, being Open Source . In the mentioned articles we also analyzed and discussed the use of virtual and remote laboratories in the training of future engineers. Recently the European Union [8] explored three basic propositions indispensable in the Future of Digital and Online Learning in Higher Education: (1) providing access to accessible digital technology; (2) developing digital skills and competences; (3) implementing a digital learning culture. The paper reflects the collaboration in the field of Online Engineering between the Faculty of Engineering, the Menoufia University, Egypt, and the Faculty of Electrical Engineering, the Technical University "Gh. Asachi" from Iasi, Romania and in the context of the Erasmus Plus Program of the European Union. The cooperation between our universities began in 2017 and have result in the publication of a number of articles ISI Thomson and IEEE indexed in 2018 and 2019, 2020, and 2021.

Keywords: *E-Pedagogy, Blended learning and Teaching, Electrical and Computer Engineering Program, Virtual Learning Environment, Open Educational Resources.*

1. Introduction

The paper presents: how to prepare STEM teachers and students to use blended learning environments; BTL course components and activities for electrical and computer engineering education; and an example of application of educational objectives of *Bloom* and *Anderson* & *Krathwohl* taxonomy. In fact the paper is a Synthesis and a continuation of previous papers [1]-[7] most of these papers are available on the internet being Open Source .

In the mentioned articles we also analyzed and discussed the use of virtual and remote laboratories in the training of future engineers.

Very recently the European Union [8] explored three basic propositions that are found to be indispensable in the Future of Digital and Online Learning in Higher Education:

(1) providing access to accessible digital technology;
(2) developing digital skills and competences;
(3) implementing a digital learning culture.

2. Preparing STEM Teachers and Students to Use Blended Learning Environments

The preparation of teachers for blended and online teaching should contain:

A. Online Teaching Skills

In order to master new knowledge and competences Instructors have to understand:

- Teaching online vs. teaching face-to-face (similarities and differences)
- Online teaching skills (Pedagogical, Technical; Administrative)
- Self-assessment activity.

B. Instructional Design Models and Theories of Learning

Instructional Design is a specific subject for online learning.

Learning theories (from behaviourism, cognitivism, constructivism and connectivism) will be identified in relation to common instructional design models such as: ADDIE (Analysis, Design, Development, Implementation, Evaluation); *Gagne*'s Nine Events of Instruction.

Table 1- Instructional Design Models and Learning Theories. The Nine Stages of *Gagné*'s Training

***Gagne*'s Nine Events of Instruction**	***Sequence of Screen*s**
1. Catching the attention; 2. informing students about objectives; 3. stimulating previously learned notions; 4. content presentation; 5. providing "guidance during the learning process"; 6. obtaining performance / through practical activity; 7. providing a feedback; 8. performance evaluation and certification; 9. improving the fixation of knowledge and the transfer of skills for specific activities at work)	0. Lesson Title 1. Lesson Objectives 2. Introduction. Prior Knowledge Needed to Complete and Understand the Lesson 3. Dictionary of New Terms 4. Examples 1. (Text, Images) 5. Example 2. (Some Video-Audio) 6. Examples 3. (Recommendations) 7. Information (Dictionary Wiki Type) 8. Knowledge Check: Tests 9. Theme with 1 example. With Indication: Initially Hidden. Then (with Click!) Visible. 10. Bibliographic References

In Table 1 is presented didactic scenario for collaborative e-teaching and autonomous e-learning.

ADDIE (Analysis, Design, Development, Implementation, Evaluation) is a project management tool for creating successful instructional design plans for Blended Learning Activities

Pedagogical Support is on the basis of Instructional Design Model (Figure 1) which is composed by:

1. Analysis (Figure 2)

▪Designer will detect

-Knowledge and skills of the learner

-Important goals that need to be established

-Who is the target audience

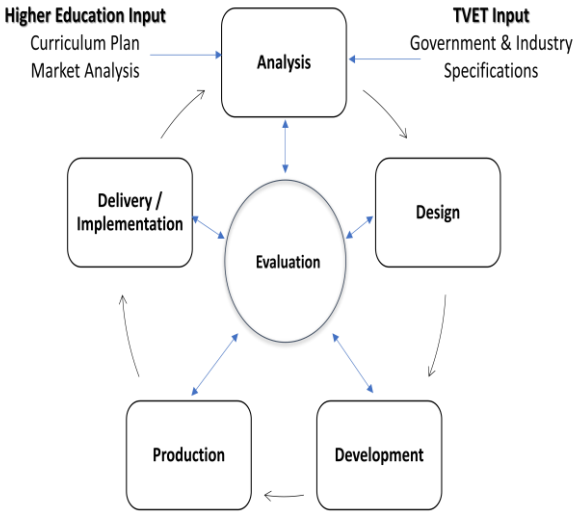

Figure 1- Instructional System Design (ISD) Model. TVET (technical and vocational education and training)

▪Designer can also determine

-Environment

-Delivery of learning objectives

-Time frame of project completion

Identification of learning objectives, goals, audience, delivery options, and timeline of project was the main focus during the initial analysis phase.

2. Design

▪Design the structure of the course

-Coordinate your objectives

-Identify contents and strategies based on behavioral results

-Analyze information

Create prototype

The designer implements visual design

-Graphic design

-Interface

-Media selection

The second phase dealt with the design of the learning platform, experiment planning, contents to publish, media selection, arrangement of various formats of the contents and prototyping by means of Instructional Objectives.

3. Development

▪Produce the actual learning criteria

-Develop course materials

-Add assignments

-Create quizzes and assessments

-Review and revise course objectives

-Do a pilot test for a final review

Next, lab developers designed the experiments and performed continuous testing, validation, and debugging for the labs during the development phase (Figure 3).

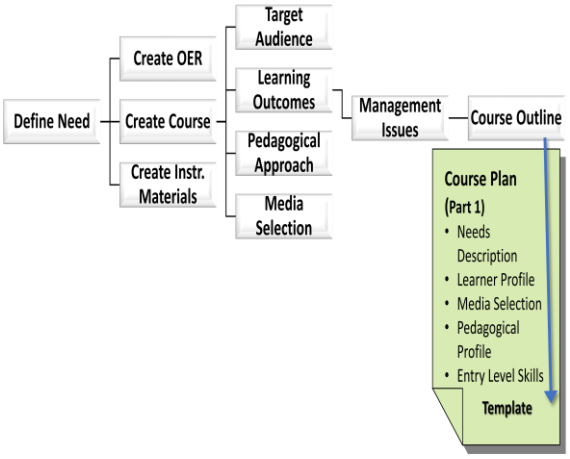

Figure 2- Analysis Process. The Analysis Phases

4. Implementation

▪Training procedure is developed for facilitators and learners

This will cover:

-Curriculum

-Outcome

-Method of delivery

-Procedures for testing

Ensuring the proper placement of contents, tools, and media as well as the procedure for training educators and students were carried out in the implementation phase.

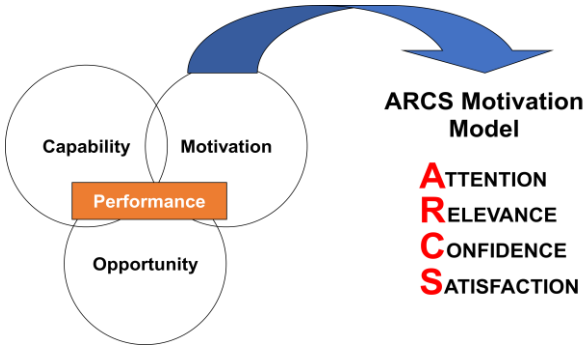

Figure 3- Motivation and Instruction. From *Keller, J.M.* (1999). Motivational Systems. In *Stolovitch & Keeps* (eds.). Handbook of Human Performance Technology.

5. Evaluation

▪Formative Evaluation

-This part of the evaluation is presented in every phase of the ADDIE model.

▪Summative Evaluation

-Opportunity to receive feedback from the learner.

-If necessary, revisions are made at this point.

The Formative Evaluation was conducted for each individual stage of the process, and the resulting feedback information was immediately integrated into process revisions for that stage.

The Summative Evaluation was performed by collecting feedback from users and incorporating their suggestions.

C. Online Course Development

Planning to Teach Online has few steps:

The Importance of Planning; Process of Online Course Development (Institutional Procedures and Resources; Instructional Design Team Members' Roles);

Lesson Plan / storyboard (Purpose; Main Elements)

An online teacher has to:

Explain the importance of the course planning process; Explain the stages in online course development;

Identify roles and responsibilities of different team members in online course development;

Develop a lesson plan (storyboard) for one module (week, unit, lesson) of their future online course.

D. Learning Outcomes as Master Plan for Design

The role of learning outcomes in online, face-to-face and blended course design is explained.

Blended teachers will use Bloom's Taxonomy of Educational Objectives to develop clear learning outcomes for an online or blended course or module.

They will also evaluate students learning outcomes to make sure they are specific, measurable, attainable, relevant and timed appropriately for the length of your course or module.

Table 2- Educational Objectives of *Bloom* and *Anderson* & *Krathwohl* Taxonomy

The six categories are:	
(1) Knowledge	(1)Remembering
(2) Agreement	(2)Understanding
(3) Application	(3)Applying
(4) Analysis	(4)Analysing
(5) Synthesis	(5)Evaluating
(6) Evaluation.	(6)Creating
Bloom's Taxonomy (1956)	Revised Taxonomy *Anderson & Krathwohl* (2001)

The numbers in parentheses are based on the six learning categories in Bloom's Taxonomy Education Objectives (Tables 2 and 3).

Traditionally, categories 4 to 6 are considered more important, requiring higher-level thinking skills.

Bloom's Taxonomy of Educational Objectives (guide to choosing action words) contains: Affective, Cognitive, and Psychomotor domains; as well as Action Words for Learning Domains

Table 3A- *Bloom*'s Taxonomy of Education Objectives

Six categories of learning	(1) Knowledge / Remembering	(2) Comprehension / Understanding	(3) Application
Student	Simple Memory/General knowledge	Student knows and understands information.	Student knows, understands, and uses information.
Computer Tool:	Drill and Practice.	Visualization software, tutorials	Internet research, Databases, Spreadsheets, Simulations
Internet Task:	As students read articles and triangulate to determine the accuracy of facts, they learn the facts.	In order to avoid plagiarism, students must summarize information and relay it in their own words.	The use of an Internet based simulation / game would be useful here.

Table 3B- *Bloom*'s Taxonomy of Education Objectives

Six categories of learning	(4) Analysis	(5) Synthesis / Creating	(6) Evaluation
Student	Student knows, understands, uses and critically examines information.	Student internalizes information to generalize about and beyond what is known.	Student judges known and/or hypothesized information
Computer Tool:	Presentation Software, Visualization Software, Databases, Spreadsheets, Simulations	Presentation Software, Word Processing	Presentation Software, Word Processing, Internet Research
Internet Task:	During the process of triangulation, students must examine, compare and test information and ideas for accuracy and logic	When students write their report, they create a new piece of work compiling ideas and facts as well as generating conclusions.	When students write a conclusion for their report they judge among competing ideas and draw a conclusion.

Some topics useful are: Introduction to Course Design Cycle; Constructive Alignment (Learners construct meaning from what they do to learn. The teacher makes a deliberate alignment between the planned learning activities and the learning outcomes.)

Methods for Writing Learning Outcomes (Table 4): Learning Outcome statements may be broken down into three main components: an action word that identifies the performance to be demonstrated; a learning statement that specifies what learning will be demonstrated in the performance; a broad statement of the criterion or standard for acceptable performance.

Table 4- Learning Outcomes as Blueprints for Design SMART

S	Specific skills/values/knowledge
M	Measurable and/or demonstrable
A	Attainable by students at current level
R	Relevant for students, course, program, degree
T	Timed appropriately for module or course length

Evaluating Learning Outcomes or SMART outcomes means: Specific skills/value/knowledge; Measurable and/or demonstrable; Attainable by students at current level; Relevant for students, course, program, degree; Timed appropriately for module or course length

Evaluating Achievement of Learning Outcomes refers to: Assessment Strategies

E. Benefits and Challenges of Online Education

This module addresses the benefits and challenges of online teaching and learning for both instructors and students.

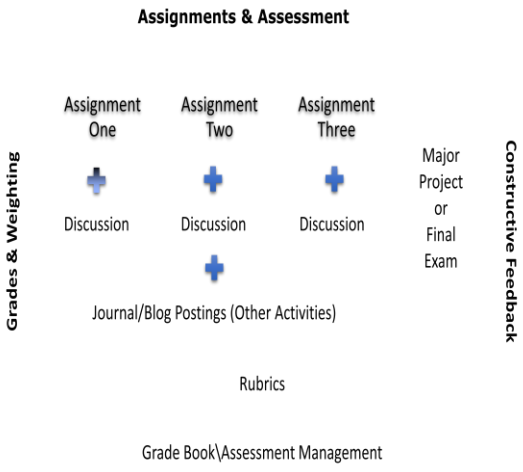

Figure 4- Relationship between Assignments & Assessment

They will review the skills required for successful teaching and learning in online environments, as well as discover strategies to overcome challenges and techniques to assist students. This module is designed to help instructors feel prepared to teach online.

F. Assessment in Online Environments

Strategies for planning assessments, grading student work and providing effective feedback in online learning environments are presented.

Teachers have to master: Place and Purpose of Assessment (Figure 4): Assessment in Constructive Alignment; Formative and Summative Assessment; Assessment Tools and Activities; Effective Feedback through Grading Rubrics: Characteristics of Effective Feedback; Grading Rubrics.

G. Communication Strategies in Online Environments

Teachers have to master tools and strategies that can help them communicate effectively with students in the online environment. They will review how they can apply the Community of Inquiry model to increase cognitive, social and teaching presence, as well as tips and techniques for planning and moderating effective online discussions. Teachers have to know design a communicative learning activity to increase interactivity in the online environment.

Teachers have to learn and understand following subjects: Online Courses as "Communities of Inquiry":

What is Community of Inquiry; Cognitive, Social & Teaching Presence;

Types of Asynchronous Communication: Meaningful Online Discussion; Discussion Board/Forum Facilitation;

Types of Synchronous Communication: When to Use Synchronous Communication;

Preparing for a Synchronous Session. The model of a community of inquiry consisted of three key elements of an educational experience: Teaching presence, cognitive presence, and social presence.

H. Synchronous and Asynchronous Tools

Appropriate synchronous and asynchronous technological tools for online learning activities and communication have to be understood (Table 5).

Teachers are expected to apply one synchronous and one asynchronous tool in the design of an online or blended course or module (Figure 5).

Educational technologies such as: discussion boards (forums), web-conferencing, blogs, wikis and social media will also be evaluated.

Online forums are also known as discussion boards or message boards. They enable users of a website to interact with each other by exchanging tips and discussing topics related to a certain theme.

Learning through online forums is an important learning strategy for students to improve their language skills.

E-Learning participants have to be able to: Evaluate a variety of educational technologies on the basis of hands-on experience, including experience with LCMS (Learning and Content Management Systems, as Moodle, Blackboard, or Microsoft Teams), email, discussion boards, blogs, ePortfolio, wikis, social media, text chat, and web-conferencing.

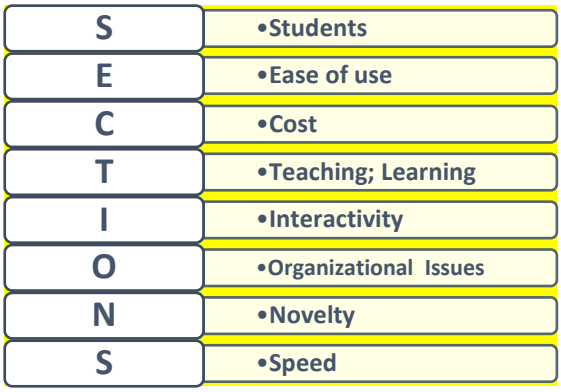

Figure 5 SECTIONS Model for Selecting Technology

I. Online Learning Communities

Strategies for building a sense of community among online learners and activities based in social learning theory to ensure successful educational experiences are essential. Methods for developing online social presence and identify strategies and activities for developing and maintaining supportive online communities are compared.

Table 5-Pedagogical Techniques For Blended Teaching And Learning In Engineering Education.

Most Widely Used e-Pedagogical Techniques	Future e-Pedagogical Techniques
1. Group problem-solving and collaborative tasks	1. Authentic cases and scenario learning
2. Problem-based learning	2. Simulations or gaming
3. Discussion	3. Virtual team collaboration
4. Case-based strategies	4. Problem-based learning
5. Simulations or role play	5. Coaching or mentoring
6. Student-generated content	6. Guided learning
7. Coaching or mentoring	7. Self-paced learning
8. Guided learning	8. Exploration or discovery
9. Exploratory or discovery	9. Modelling of the solution process
10. Lecturing or teacher-directed activities	10. Discussion
11. Modelling of the solution process	11. Debates and role play
	12. Lecturing or instructor-directed activities
	13. *Socratic* questioning

Teachers have to know how to: Define Online Learning Communities: Function; Identity; Participation; Interaction Online Learning Communities and Online Classes/Collaboration:

Using Ice-breakers/Intros in Online Spaces; Learner/Peer Feedback; Group Assignments; Strategies to Develop Successful Online Learning Communities: Modeling; Articulation; Coaching; Exploration; Reflection; Scaffolding.

Coaching is a form of development in which a person called a coach supports a learner or client in achieving a specific personal or professional goal by providing training and guidance.

In a course entitled Fundamental principles of educational technology, ICT, media and e-learning (3 ECTS credit), component of the ING.PAED.IGIP CURRICULUM, are presented: Technical devices, equipment and systems used to support instruction. The operation of these media and e-learning, their sensible use and integration into the instructional process are the main problems dealt with in this unit.

3. BTL Course Components and Activities for Electrical and Computer Engineering Education

Instructional model with a blended-learning approach provides more individualized instruction than traditional face-to-face tuition. It enables learners to accommodate the space/time demands of other interests, as students can carry on other everyday activities without having to adapt to strict space/time constraints (Table 6).

Table 6-Typical Blended Teaching and Learning Engineering Course Components

Blended Learning Engineering Course	
Online (BTL, e-Learning) Components	Face-to-Face (F2F) Components
■Educational Materials & Assessments: ▪Lecture Notes ▪Lecture Presentations ▪Additional Reading Materials ▪Virtual Laboratories (Labs) ▪Assignments ▪Online Quizzes & Tests ▪Video & Audio Clips of material ▪Video Conference material ▪Webcasted Lecture	■Educational Materials & Assessments: ▪Lab Sessions ▪Supplemental Tutorial Sessions (if needed) ▪Project implementations ▪Semester-end Examinations ▪Workshop Component of a Course (if any)
■Educational Support: ▪Announcements of course-related matters ▪E-mail ▪Discussions Groups ▪Student faculty interaction	■Educational Support: ▪Manual payment of fees ▪Physical meeting with advisers
■Course Management: ▪Course registration ▪Course Add/Drop ▪Course Withdrawal ▪Online fees payment	

Students can work cooperatively. Cooperative activities help to promote information exchange flows among students, build up cognitive knowledge construction processes, and strengthen motivational and informal affective bonds of mutual support and friendship.

This blended learning process as a possible working scenario consists of a 15-week course executed as follows:

1) The course kicks off with a one-day face-to-face session where the learners have the chance to meet each other and the instructor. The instructor presents the learning objectives, discusses the most significant knowledge and tasks to be learned, and describes computer-mediated interaction (e-mail, chats, and forums).

2) Every week, there is a 2-h face-to-face session where students ask the instructor questions about the contents they have studied over the last week and discuss problems that they have encountered and possible solutions. The instructor presents the most important contents to be studied over the following week, stressing the concepts that are most important or harder to learn.

3) One-hour interactions between learners and the instructor are held every week via chat and/or forums to consolidate and acquire knowledge. These sessions are held informally, and their development is not structured. These sessions are especially important for students that were unable to attend the face-to-face session.

4) There is permanent e-mail support, and queries should be answered within 24 h.

5) Face-to-face support is available to students 6 h a week. Learners can meet the instructor either individually or in groups to clarify contents and receive support on how to solve the good problems.

6) An online assessment is held every week, where the students have to complete a five-question questionnaire.

7) A final face-to-face assessment is held immediately after the course has finished. Students have to sit a 10-question examination, where they will be expected to complete short exercises on a common problem similar to the ones used in the good problems. The examination typically lasts 2.5 h. Learner evaluation takes into account the scores achieved in this test, the solution of the weekly questionnaires, the solutions given to the good problems set throughout the course, and the learner's participation in live e-learning sessions.

Blended engineering courses are designed by using CDIO (Conceive--Design--Implement—Operate) Approach

4. An Example of Application of Educational Objectives of Bloom and Anderson & Krathwohl Taxonomy

Course organization is based on Bloom's taxonomy of education objectives applied to e-learning of electric circuit theory (electrotechnics), see Table 5.

There are considered:

•the objectives for chapter ac power analysis:

1 introduction;
2 instantaneous and average power;
3 maximum average power transfer;
4 the effective value;
5 apparent power and power factor;
6 complex power;
7 conservation of ac power;
8 power factor correction;
9 applications;
9.1 power measurement;
9.2 electricity consumption cost)

and

•the objectives (see Table 7) for the review of single-phase power and power factor correction,

solve for the real, reactive, apparent, and complex power of a circuit and

determine the power factor (leading or lagging);

use the power triangle to relate the power components of a given circuit;

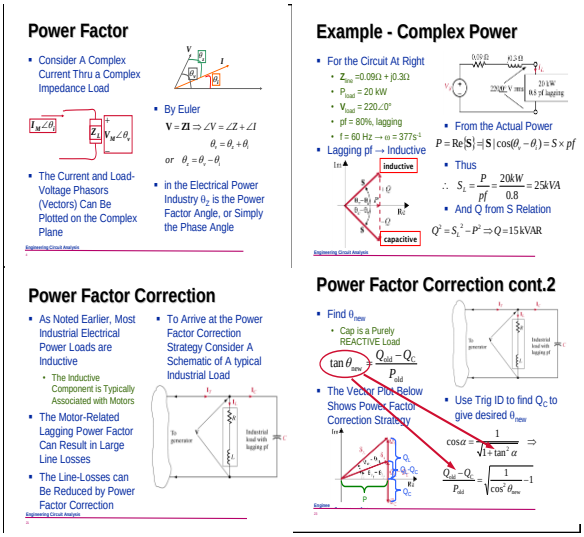

Figure 6 Power Factor Correction

explain the purpose of performing power factor correction ؛

determine the reactive power and capacitance required to obtain a specified power factor, see Figure 6.

It is obvious that learning in the knowledge society involves an effort to renew teaching practices by integrating the innovations brought by the new information and communication technologies, this effort assuming courage, creativity and collaborative activism from several actors, both "traditional" (teacher, didactician, school manager, etc.), as well as "modern" (computer scientist, system engineer, web-designer, etc.). The present and future challenges will be brought not only by the dynamics inherent in the contents of knowledge, but also by the ways of making them available that cannot be neglected. On the contrary, they can print another value to the learning contents, which will be put in a new light precisely by the new frames of knowledge transmission

Table 7- Objectives for Chapter AC Power Analysis

(2) Comprehension	(3) Application	(4) Analysis
Describe (2) how the power triangle for a given circuit relates to the impedance components on the complex plane. Describe (2) how the power triangle for a given circuit relates to the impedance components on the complex plane. Explain (2) the purpose of doing power factor correction.	Solve (3) for the instantaneous power p(t), average (or real) power P, reactive power Q, apparent power S, complex power S, and power factor pf for any of the elements of an AC circuit. Use (3) the power triangle to describe the power components of a given circuit or element.	Explain (4) the physical meaning of instantaneous power, average power, reactive power, apparent power, complex power and the power factor (leading or lagging).

5. Conclusions

The paper reflects the collaboration in the field of Online Engineering between the Faculty of Engineering, the Menoufia University, Egypt, and the Faculty of Electrical Engineering, the Technical University "Gh. Asachi" from Iasi, Romania and in the context of the Erasmus Plus Program of the European Union.

In this paper, we have reviewed the recent and programmatic documents of: the European Society for Engineering Education (SEFI), the International Society for Engineering Education (IGIP), the Institution of Electrical and Electronics Engineers (IEEE), the International Association of Online Engineering (IAOE), and the American Society for Engineering Education (ASEE) to identify the

specific pedagogical characteristics used in the BTL process.

The cooperation between our universities began in 2017 and have resulted in the publication of a number of articles [1]-[7] in Intl. Conf. Proceedings (ISI Thomson and IEEE indexed) in 2018 and 2019, 2020, and 2021.

Both Students and Professors will use the BTL Methods in Iași, and Menoufia. The integration of online laboratories (both Virtual and Remote) in the engineering training process, the use of Virtual Learning Environments (VLE), the inclusion of Open Educational Resources (OER) are the strategies used in this project.

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