



HAL
open science

2018 ICVL: Blended Learning Methodologies and ePedagogical Approaches Used in an Electrical and Computer Engineering Education Program Leading to International Accreditation

Adrian Adascalitei, Ashraf Salah El-Din Zein El-Din, Marinela Costel Temneanu, Sebastian Teodor Aradoaei

► To cite this version:

Adrian Adascalitei, Ashraf Salah El-Din Zein El-Din, Marinela Costel Temneanu, Sebastian Teodor Aradoaei. 2018 ICVL: Blended Learning Methodologies and ePedagogical Approaches Used in an Electrical and Computer Engineering Education Program Leading to International Accreditation. The 13th International Conference on Virtual Learning ICVL 2018, University of Bucharest; “December 1st 1918” University of Alba Iulia, Oct 2018, Alba Iulia, Romania. pp.63-77. hal-04405197

HAL Id: hal-04405197

<https://hal.science/hal-04405197>

Submitted on 19 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Blended Learning Methodologies and ePedagogical Approaches Used in an Electrical and Computer Engineering Education Program Leading to International Accreditation

**Ashraf Salah El-Din Zein El-Din¹, Adrian
Adăscăliței², Marinel Temneanu², Sebastian Arădoaei²**

⁽¹⁾Faculty of Engineering, Menoufia University
Gamal Abd El Nasr St. - Shebin ElKoum - Menofia, EGYPT
E-mail: ashrafzeineid[at]sh-eng.menofia.edu.eg

⁽²⁾Faculty of Electrical Engineering, Technical University "Gh. Asachi", Iași, ROMÂNIA
E-mail: adrian.adascalitei[at]gmail.com; arsete[at]ee.tuiasi.ro; mtemnean[at]ee.tuiasi.ro

Abstract

This review paper describes Blended Learning methodologies and pedagogical approaches which use ITC in the field of electrical and computer engineering education program leading to international accreditation. In this paper, we review also recent ASEE (American Society for Engineering Education), IEEE (Institution of Electrical and Electronics Engineers), SEFI (European Society for Engineering Education), and IGIP (International Society for Engineering Education) papers to identify which pedagogical aspects of the instructional process have been published in the focus of this research area. Paper also reflects the experience of Technical University "Gh. Asachi" from Iasi, Romania, and Menoufia University, Egypt, with this approach applied to Project ECEP (Development and Improvement of Curricula in the field of Electrical and Computer Engineering Program Leading to International Accreditation).

Keywords: ePedagogy, Curriculum, Teaching and Learning Practices, Teacher Education, Electrical and Computer Engineering Education

1 Introduction

This review paper describes Blended Learning methodologies and pedagogical approaches which use ITC in the field of electrical and computer engineering education program leading to international accreditation. In this paper, we review also recent ASEE (American Society for Engineering Education), IEEE (Institution of Electrical and Electronics Engineers), SEFI and IGIP papers to identify which pedagogical aspects of the instructional process have been published in the focus of this research area. Paper also reflects the experience of the Technical University "Gh. Asachi" from Iasi, Romania, and the Menoufia University, Egypt, with this approach.

1.1 Project Review

Project: Development and Improvement of Curricula in the field of Electrical and Computer Engineering Program (ECEP) Leading to International Accreditation

Wider objectives of the project:

- To improve the quality and relevance of ECEP at Egyptian higher education institutions and to enable easier inclusion of partner country institutions into European Higher Education Area.

Specific objectives of the project:

- To improve, develop and implement accreditation standards, guidelines and procedures for quality assurance of ECEP education study programs according to EU (European Union) practices at national level in Egypt beneficiary country;

- Strengthening the international outlook and collaborations of EU with national universities in the field of electrical and computer engineering;

- Participation as peer reviewing curricula to exchange experience between EU and national universities;

- They will achieve the overall objectives to educate experts in the field of electrical and computer engineering which provides new insights into an integrated consideration of electrical, and computer engineering. Future educated experts will be able to manage complex projects for international institutions and companies operating in Arabic region.

After completion of the full time program participants will:

- Exhibit academic and practical expertise in their specific field of work, intercultural and management competencies, and regional as well as language skills for becoming experts for working in projects in relation to development policy;

- Contribute to their respective working environment more efficiency, using specialist-technical knowledge linked up with overarching competencies such as communication skills and a holistic approach to solving problems;

- Be able to contribute to their working environment in a practice and demand oriented way, however, based on solid academic knowledge.

The training of engineer teachers in the project will meet the requirements promoted by SEFI, IGIP, EU, ASEE, and IEEE in the areas of:

- Learning and teaching methodologies and pedagogical approaches;

- Advanced training in e-learning techniques. (eLearning is interactive learning in which the learning content is available online and provides automatic feedback);

- Design website and e-learning platform; new teaching materials, adaptation / translation of existing teaching materials[41].

2 International Accreditation of Engineering Education

Globalization and new technologies have opened up a global market for education pressuring many institutions to be internationalized [31].

Internationalisation in higher education usually refers to exchange programmes and student mobility. Its increasing importance is the consequence of multiple changes in the environment for higher education which includes the growth of the global information, knowledge-based economy and opening of the international labour market. Since internationalization of higher education can be seen as a proactive response to the catalyst globalisation, emergence of an international market for higher education poses challenges on both global and national level.

Using Blended Learning classes and Virtual and Remote labs for international engineering education is one of the main objectives of the project.

UNESCO Four Pillars of Learning are fundamental principles for reshaping engineering education:

- **Learning to know:** to provide the cognitive tools required to better comprehend the world and its complexities, and to provide an appropriate and adequate foundation for future learning.
- **Learning to do:** to provide the skills that would enable individuals to effectively participate in the global economy and society.
- **Learning to be:** to provide self analytical and social skills to enable individuals to develop to their fullest potential psycho-socially, affectively as well as physically, for **an** all-round 'complete person.

- **Learning to live together:** to expose individuals to the values implicit within human rights, democratic principles, intercultural understanding and respect and peace at all levels of society and human relationships to enable individuals and societies to live in peace and harmony.

2.1 Accreditation System for Engineering Education (EE) in EU.

European Society for Engineering Education (SEFI) [30]. SEFI's position on Accreditation in EE:

One of the main goals of the accreditation of Engineering Education (EE) programs is to ensure transparency and hence build TRUST, favouring mobility of students and engineers;

A European accreditation system for EE should respect the rich cultural diversity of European HE (Higher Education) Institutions;

SEFI fully supports the development of the EUR-ACE System, since it is fully compatible with the requirement mentioned in the previous point, being based on cooperation and mutual recognition between existing National accreditation bodies, and being based on LO (Learning Outcomes) for its implementation;

SEFI also appreciates the fact that the EUR-ACE System has acquired global visibility through contacts with the Washington Accord, the Sydney Accord, and the whole International Engineering Alliance (IEA);

SEFI encourages all its HE institutional members to apply for EUR-ACE labels for their programs;

SEFI encourages HE institutional members in countries that have not yet an established EE accreditation procedure to solicit the relevant authorities in this direction, and in the meantime to take advantage of the possibility to let one of the EUR-ACE-authorized agencies accredit (some of) their EE programs;

SEFI wishes to ensure its strong support and involvement regarding ENAEE (European Network for Accreditation of Engineering Education) activities, and in particular supports the idea of submitting to the EC (European Community, European Union) a new application to further advance the European system for accreditation of EE, in which SEFI intends to play an active role.

EUR-ACE (European Accredited Engineer) [29] is a system for accreditation of EE programs, first defined in 2006, that follows the main recommendations of the 2001 SEFI's position paper. In particular, EUR-ACE respects the rich cultural diversity in EE among European HE Institutions. EUR-ACE has been developed with the support of a sequence of EC-DG EAC (Directorate-General for Education, Youth, Sport and Culture, of the European Commission) projects from 2004 to 2010. SEFI strongly supports the further development of the EUR-ACE System, as it constitutes the first and a successful example of pan-European accreditation system in EE. It must be remembered that the learning objectives of EUR-ACE, defined in the EUR-ACE Framework Standards, are fully compatible with the European Qualification Frameworks, apply to first and second level degrees, as well as "integrated (long) degree" programs, and can be used also by institutions in countries that have not yet established a National engineering accreditation agency.

Criteria to be satisfied by ECEE programmes to be accredited include the following:

- The teaching and learning environment is appropriate to the programme objectives, programme structure, preparedness of the students at intake, and the stated outcomes, for example, as evidenced by: a progressive learning experience, development of independent learning, effective programme co-ordination, and monitoring student progress;
- Students have access to sufficient literature and computer resources to support their learning.

3 ECEE (Electrical and Computer Engineering Education) Curriculum

3.1 Engineering Education

Engineering education is the activity of teaching knowledge and principles to the professional practice of engineering.

The aims of the International Society for Engineering Education - IGIP are:

- To improve teaching methods in technical subjects
- To develop practice-oriented curricula that correspond to the needs of students and employers
- To encourage the use of new media in technical teaching
- To integrating languages and the humanities in engineering education
- To foster management training for engineers
- To promote environmental awareness
- To support the development of engineering education in developing countries

3.2 SEFI and IGIP Curriculum Engineering Education Model

The following didactical and organisational principles were formulated as guiding principles for Curriculum Engineering Education Model:

1. A steady workload is better than 'binge learning' for tests;
2. Frequent and adequate feedback helps students adjust learning;
3. A variety in teaching methods keeps students engaged;
4. Community helps students help each other;
5. Ambitions must be clear and high, yet realistic; and
6. Teachers work best in teams, with minimal regulation.

3.3 Electrical Engineering Education

The teaching in undergraduate courses in the STEM disciplines has increasingly started adopting the more learner-centred teaching, such as problem based learning [16]. This shift is fuelled by the need for future engineers to demonstrate the use of higher order thinking, problem solving, and more interpersonal aspects of a career, such as communication, social, and team-work skills (National Academy of Engineers, NAE, 2005). Specifically, the engineering field is seeing shifts in the types of engineers needed to emerge from college who are ready to participate as active and effective members of a global society. The National Academy of Engineers (NAE, 2004) developed a set of attributes future engineers will have to possess to be a competitive force within the field. Hence, it is important for engineering education to re-examine the use of typical lecture-based teaching methodology and consider incorporating learner-centred teaching. One such approach, problem-based learning (PBL) has the potential to help students to cope with the demands of complexities of the field and problems they will face in their future careers.

PBL develops the following skills of students: *Teamwork; Project management and leadership; Oral and written communication; Emotional intelligence; Tolerance for uncertainty; Critical thinking and analysis; Application of content knowledge; Research; Decision making; Problem solving across disciplines.*

3.4 Computer Engineering Education, BL Course Components and Activities

Instructional model [7] 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. 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.

4 e-Learning, Blended Learning,

Designing blended engineering courses using CDIO (Conceive--Design--Implement—Operate) Approach [7]

Course design should be based on a well-constructed curriculum and properly formulated intended learning outcomes.

The core of course design is selecting Teaching and Learning Activity (TLA). That requires an open mind on how students learn and considering the use of each available type of TLA. [5] Laurillard synthesised a list of TLAs from theories of learning:

- Acquisition: reading, watching, listening.
- Inquiry: using resources to develop an evidence-based output.
- Discussion: debating, questioning, answering, negotiating ideas.
- Practice: acting, in the light of feedback, to achieve a goal or output.
- Collaboration: working with others to achieve a joint output.
- Production: making something for others to evaluate against agreed criteria.

Most Learning Management Systems (LMS) were developed to support the TLAs (acquiring, inquiring, producing and practicing) and sometimes they extend to discussing and collaborating.

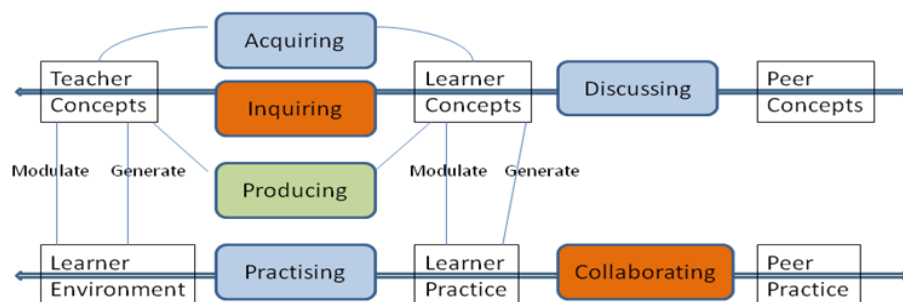


Fig. 1. TLAs and supported processes (from van Puffelen[14], based on Laurillard[3])

There are limits in replacing on-campus TLAs by online versions. It seems that students need a minimum amount of on-campus teacher-student contact and higher level engineering ILOs require rich on-campus collaboration work that cannot be completely offered online; (ILO, intended learning outcomes).

Trends and Predictions Related to Blended Learning

1. Mobile blended learning. Increasing use of mobile and handheld devices will create rich and exciting new avenues for blended learning

2. Greater visualization, individualization, and hands-on learning. Blended learning environments will increasingly become individualized, in particular, emphasizing visual and hands-on activities.

3. Self-determined blended learning. Blended learning will foster greater student responsibility for learning. Decisions about the type and format of blended learning will be made by students instead of instructors or instructional designers. Learners will be designing their own programs and degrees.

4. Increased connectedness, community, and collaboration. Blended learning will open new avenues for collaboration, community building, and global connectedness. It will be used as a tool for global understanding and appreciation.

5. Increased authenticity and on-demand learning. Blended learning will focus on authenticity and real world experiences to supplement, extend, enhance, and replace formal learning. As this occurs, blended learning will fuel advancements in the creation and use of online case learning, scenarios, simulations and role play, and problem-based learning.

6. Linking work and learning. As blended learning proliferates, the lines between workplace learning and formal learning will increasingly blur. Higher education degrees will have credits from the workplace and even credit for work performed.

7. Changed calendaring. The calendar system or time scheduling of learning will be less appropriate and predefinable.

8. Blended learning course designations. Courses and programs will be increasingly designated as blended learning paths or options.

9. Changed instructor roles. The role of an instructor or trainer in a blended environment will shift to one of mentor, coach, and counsellor.

10. The emergence of blended learning specialists. There will emerge specialist teaching certificates, degree programs, and resources or portals related to blended learning courses and programs.

Table 1. Typical Blended Learning Engineering Course components

Blended Learning Engineering Course	
Online (e-Learning) Components	Face-to-Face (F2F) Components
Educational Materials & Assessments: <ul style="list-style-type: none"> ▪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: <ul style="list-style-type: none"> ▪Lab Sessions ▪Supplemental Tutorial Sessions (if needed) ▪Project implementations ▪Semester-end Examinations ▪Workshop Component of a Course (if any)

<p>Educational Support:</p> <ul style="list-style-type: none"> ▪Announcements of course-related matters ▪E-mail ▪Discussions Groups ▪Student faculty interaction 	<p>Educational Support:</p> <ul style="list-style-type: none"> ▪Manual payment of fees ▪Physical meeting with advisers
<p>Course Management:</p> <ul style="list-style-type: none"> ▪Course registration ▪Course Add/Drop ▪Course Withdrawal ▪Online fees payment 	

4.1 ITC for Engineering Education. Virtual Learning. Virtual Campus. Virtual Lab. Virtual Learning Environments.

MOODLE (moodle.org; moodle.com) is a tool which enables you to create a website environment for your class with online activities such as forums and quizzes.

Virtual Learning Environments, such as Moodle, are easy, free, and relatively safe to use:

- The Moodle website can be set up to allow only your students to enter it and explore it.
- It is a controlled environment for your students to use the internet.
- Because it's free, many educational institutions use it.
- This can allow you to share content and ideas with other teachers easily.

4.2 Open Educational Resources (OER) and Massive Open Online Courses (MOOCs)

Open educational resources (OER) are freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes.

Massive Open Online Courses (MOOCs) was originated in 2008 within the Open Educational Resources (OER) movement. MOOCs are open online courses that are more structured formal and aiming at large-scale interactive participation. Only a few percent of the tens of thousands of students who may sign up complete the course.

Typically they do not offer academic credit or charge tuition fees but in some cases they offer the possibility of earning academic credit or certificates based on supervised examinations. Subsequently, several providers by elite universities have emerged such as edX, which was founded by MIT and Harvard University.

4.3 Technology Enhanced Learning (TEL) for Engineering Education

Technology enhanced learning (TEL) is often used as a synonym for e-learning but can also be used to refer to technology enhanced classrooms and learning with technology, rather than just through technology.

Implementing TEL for Engineering Education focuses in particular on pedagogical and learning support issues raised by the fusion of e-learning environment systems with digital libraries and resources. Taking the position that access to digital content is not synonymous with e-learning but is an essential element of it, Allison Littlejohn illustrates the role of information access, sharing and use within the context of a constructivist model for e-learning design. With reference to three practical scenarios in e-learning design and delivery, she highlights potential directions for the learning support contribution of the librarian, with impact on both educational development and student learning.

5 e-Pedagogy for Online-Learning, e-Learning, Blended Learning. Teaching and Learning Practices and Teacher Education in Electrical and Computer Engineering Programs

Key learning theories and models, their characteristics, and how they might be realised in the context of e-learning are presented in Table 2 [11].

Table 2. Summary of key learning theories and models, their characteristics, and how they might be realised in the context of e-learning

Theories / Literature	Main characteristics	Potential e-learning applications
Behaviourism / •Skinner; •Tennant	<ul style="list-style-type: none"> •Focuses on behaviour modification via stimulus-response pairs •Trial and error learning •Learning through association and reinforcement •Pedagogical focus is on control and adaptive response •Focus on observable outcomes 	<ul style="list-style-type: none"> •Much of current e-learning development represents little more than transfer of didactic approaches online, the 'web page turning mentality' linked directly to assessment and feedback
Cognitive / •Anderson; •Wenger; •Hutchins; •Piaget	<ul style="list-style-type: none"> •Focus on internal cognitive structures; views learning as transformations in these cognitive structures •Focus on human development •Pedagogical focus is on the processing and transmission of information through communication, explanation, recombination, contrast, inference and problem solving •Useful for designing sequences of conceptual material which build on existing information structures 	<ul style="list-style-type: none"> •Salomon's notion of distributed cognition (Salomon, 1993) could lead to a more shared knowledge structure between individual and surrounding information rich environment of resources and contacts •Development of intelligent and learning systems, and the notion of developmental personalised agents
Constructivist / •Papert; •Duffy & Jonassen	<ul style="list-style-type: none"> •Focus on the processes by which learners build their own mental structures when interacting with an environment •Pedagogical focus is task-orientated •Favour hands-on, self-directed activities orientated towards design and discovery •Useful for structured learning environments, such as simulated worlds; construction of conceptual structures through engagement in self-directed tasks 	<ul style="list-style-type: none"> •The concept of toolkits and other support systems which guide and inform users through a process of activities could be used to good effect to embed and enable constructivist principles •Access to resources and expertise offers the potential to develop more engaging and student-centred, active and authentic learning environments •Microworlds and simulations
Activity-based/ •Vygotsky, '34; •Wertsch, 85; •Engestrom, '87	<ul style="list-style-type: none"> •Focus on the structures of activities as historically constituted entities •Action through mediating artefacts within a framework of activity within a wider socio-cultural context of rules and community 	<ul style="list-style-type: none"> •In the last decade there has been a shift from a focus on the information (and in particular content) aspects of ICT to an emphasis on communication, collaboration and understanding

Theories / •Literature	Main characteristics	Potential e-learning applications
	<ul style="list-style-type: none"> •Pedagogical focus is on bridging the gap between historical state of an activity and the developmental stage of a person with respect to that activity e.g. current state of language use and child's ability to speak a language •The Zone of Proximal Development—the idea that assessing current ability gives limited insight into an individual's potential for development, which is better studied through examining their work alongside a more able peer 	<p>the factors which underpin the development of communities</p> <ul style="list-style-type: none"> •In particular there has been a realisation that the development of content alone does not lead to more effective learning, and that there is a need to structure and foster learning environments to enable communities to develop •Networking capabilities of the web enable more diverse access to different forms of expertise and the potential for the development of different types of communities
<p>Socially situated learning /</p> <ul style="list-style-type: none"> •<i>Mercer;</i> •<i>Vygotsky;</i> •<i>Laurillard;</i> •<i>Lave;</i> •<i>Wenger</i> 	<ul style="list-style-type: none"> •Take social interactions into account and learning as social participation •Emphasis on interpersonal relationships involving imitation and modelling •Language as a tool for learning and the joint construction of knowledge •Language has two functions: <ol style="list-style-type: none"> 1. a communicative or cultural tool, used for sharing and jointly developing knowledge 2. a psychological tool for organising our individual thoughts, for reasoning, planning, and reviewing our actions •Dialogue between tutor and student can be articulated into 12 levels of engagement—both external and internal •Knowledge is a matter of competences with respect to valued enterprise. Participating in the pursuit of this, i.e. active engagement •Meaning our ability to experience the world and our engagement with it as meaningful—is ultimately what learning is to produce 	<ul style="list-style-type: none"> •Multiple forms asynchronous and synchronous communication offer the potential for more diverse and richer forms of dialogue and interaction between students and tutors and amongst peers, as well as the use of archive materials and resource for vicarious forms of learning •Different online communication tools and learning environments and social for a offer the potential for new forms of communities of practice or facilities to support and enhance existing communities
<p>Experiential /</p> <ul style="list-style-type: none"> •<i>Dewey;</i> •<i>Kolb;</i> •<i>Jarvis</i> 	<ul style="list-style-type: none"> •Experience as foundation for learning •Learning as the transformation of experience into knowledge, skill, attitudes, values emotions •Reflection as a means of transforming Experience •Problem base learning a focus: 	<ul style="list-style-type: none"> •Asynchronous communication offers new forms of discourse which is not time-bound and hence offers increased opportunity for reflection •Archive and multiple forms of representation of different

Theories / •Literature	Main characteristics	Potential e-learning applications
	<ul style="list-style-type: none"> -Experience: Problem situation, identification and definition -Gather and reflecting on information -Theory formation and test in practice -Experience through Primary and Secondary -Reasoning and Reflection -Evaluation (Dewey, 1916) 	communications and experiences offer opportunities for reflection
Systems theory / •Senge; •Laurillard	<ul style="list-style-type: none"> •Focus on organisational learning, or on modelling the development of learners in response to feedback 	<ul style="list-style-type: none"> •New forms of distribution and storage, archiving and retrieval offer the potential for development of shared knowledge banks across organisations and forms of organisational distributed cognition •Models of learning account adaptation in response to both discursive and active feedback

Pedagogical Techniques for Blended Learning in Engineering Education are summarized in Table 3.

Table 3. Pedagogical Techniques for Blended Learning in Engineering Education

Most Widely Used Pedagogical Techniques	Future Pedagogical Techniques
<ol style="list-style-type: none"> 1. Group problem-solving and collaborative tasks 2. Problem-based learning 3. Discussion 4. Case-based strategies 5. Simulations or role play 6. Student-generated content 7. Coaching or mentoring 8. Guided learning 9. Exploratory or discovery 10. Lecturing or teacher-directed activities 11. Modelling of the solution process 	<ol style="list-style-type: none"> 1. Authentic cases and scenario learning 2. Simulations or gaming 3. Virtual team collaboration 4. Problem-based learning 5. Coaching or mentoring 6. Guided learning 7. Self-paced learning 8. Exploration or discovery 9. Modelling of the solution process 10. Discussion 11. Debates and role play 12. Lecturing or instructor-directed activities 13. Socratic questioning

6 Engineering Teacher Education

6.1 Technical Teacher Training. Pedagogy and e-Pedagogy for Engineering Education[4].

The engineering educational competences are to be summarized as follows:

- Pedagogical, social, psychological and normative ethical competences;
- Didactic skills and subject expertise;
- Evaluative competences;
- Organizational (Management-) competences;
- Communication and social competences;
- Self-reflexive and development competences.

Development of the new International Engineering Educator ING.PAED.IGIP Curriculum into an Umbrella for Modularised National and Regional Engineering Education Curricula [21]

Those university graduates who want to become certified engineering educators (and thus also receive the ING-PAED IGIP award) must attend the following courses in each of the four modules:

1. Introduction to teaching (organisation of institution, planning of lessons, administration, legal information), basics of engineering pedagogy;
2. Social competence (professional, vocational, pedagogical information), teaching styles, types, forms of teaching (problem-based, project-based, blended learning), learning and teaching psychology and communication;
3. Engineering education / pedagogy (vocational) work with curricula, extract information and plan a year's teaching, structuring and dividing of content, formulation of competences;
4. Teaching practice and analysis, self- and external evaluation, reflexion, quality management and control (plan, act, check, do).

In the proven *IGIP engineering educational curriculum* there are the following compulsory subjects:

Fundamental principles of Engineering Pedagogy (2 European Credit Transfer System—ECTS credits): the core module is the backbone of the curriculum – the base and integrating part of the engineering education science "Technical Teacher Training." The starting point is practically oriented technical teaching. This is understood as a process which, like any other, is subject to specific regularities and is determined by a series of components throughout its course – teaching goals (G), teaching materials (T), teaching media (M), psychological structure (P), social structure (S) and teaching methods (TM) have a complex interdependent relationship. The subject is dealing with the definition of the overall and precise objectives of a lecture, the selection and structuring of information, the different influences of technical subject matters on teaching methods – definition of terms, derivation of laws, inductive and deductive methods, programmed instruction, etc.

Engineering Pedagogy practice (3 ECTS credits): The participants are supposed to practice the design and performance of instructional units using concrete technical subject matters. Their actual performance is recorded on videotape and discussed by the group. Due to their shared experience the transfer of the learnt into real situations is achieved.

Fundamental principles of educational technology, ICT, media and e-learning (3 ECTS credit): 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.

Laboratory didactics (2 ECTS credits): Concentrates on psycho-motor aspects of technical classes, namely experimental technical work and research. Amongst others, the structure of controlled experiments should be brought across, i.e. "stating the problem, setting up hypotheses, carrying out the actual experiment, results and conclusions", as well as the various possibilities for teaching work in the laboratory, i.e. "strictly predefined experiments – selecting one experiment from many – individual topics selected by students – semester work in the laboratory", etc.

Scientific writing (1 ECTS credit): students should fulfil the requirements of research work. Scientific work at the Bachelor level is usually the first research work of the author, the topic is therefore generally rather narrow which facilitates achieving the desired insight.

Presentation and communication skills (2 ECTS credits): students will acquire basic historical and theoretical-pragmatic knowledge and skills from the field of history of rhetoric, speech technique, and vocal hygiene; by practicing they will develop aesthetic criteria for assessing verbal communication.

Rhetoric (2 ECTS credit): rhetoric should encourage awareness of the effects of speeches and lectures and at least touch on the basic problems of voice training and correct articulation, starting with the fundamentals of clarity to the fascinating persuasiveness of speech. It should be considered in the context of the communication and discussion training and should also be applied to this purpose.

Engineering Ethics (1 ECTS credit) as a study course, Engineering Ethics is closely related to Philosophy. The goal is to offer general information on European thinking advancement in the cultural-historical framework from the beginning of continental philosophy to the present. Theories of the human and problems of morality are considered.

Working with projects (1 ECTS credit) - one of the objectives of the teacher project is to have a clear relationship to a teaching experience. If a student chooses to process a textbook, it must include a didactic analysis of existing textbooks (rationale for creating a new text) and pedagogical-psychological parameters required from the textbook. If the author decided on research survey on selected issue, it is usually on a small scale investigation. Its implementation and interpretation, however, must meet all the requirements for such surveys.

Intercultural competencies (1 ECTS credit): the goal of the course is provides students with knowledge of sociopedagogical issues, focusing on the so-called multicultural education, whose mission is to eliminate barriers, prejudice and xenophobia resulting from ignorance of foreign cultures, nations and ethnic groups.

Fundamental principles of psychology (2 ECTS credits): Conditions of human learning, the process of learning, results of memory research, motivation, talent and educability (technical knowledge, comprehension and intelligence), etc.

Fundamental principles of sociology (1 ECTS credit): Functioning and dependence of social groups (classroom community as a social group, groups within school classes), the role concept of the teacher in his professional situation, teacher behaviour, student behaviour, etc.

Additionally the following elective subjects are taught: Portfolio Assessment; Coaching and Mentoring in Engineering Education; Creative and Critical Thinking; Teamwork and PBL; Standards and Quality in Engineering Education; etc.

Conclusions

In conclusion we mention the IGIP position sustained by Professor Michael E. Auer, President of IGIP, (2013) at American Society for Engineering Education summarizing the tendencies for the future of learning [33]:

- The conceptualization and implementation of a new learning model; the 21st century competencies and expertise are: critical thinking, complex problem solving, interactive collaboration, etc.

- A balanced approach between E-Learning and Face-to-Face Learning; between Formal and Informal Learning. A modern approach of teaching and learning is a blended one. We have to better exploit synergies from traditional and non-traditional education.

- The future of learning will revolve more around context than content. Our age is the Information Age. We live in the Knowledge Society where data, information, knowledge are easy to access 24/7. We need a radical change from teaching facts and knowledge to convey skills and creativity (to find necessary data, facts, and knowledge) in a global context. Therefore, learning is presently undergoing great transitions.

- The Future of Learning will be a global one, characterized by open content, open knowledge, open technology for all. Global education is the next distance-learning leap. Especially from this the necessity of a new business model in education arises.

- The future of learning is characterized by serious changes in the social position of learning. According to some estimates, more than 80% of all learning occurs on the job rather than in

tertiary and post-tertiary education. Learning in the future has to be an integrated part of the job! People of all ages have to renew their knowledge in decreasing cycles. This is what we understand as "Life Long Learning".

The program presented here is the result of "Gh. Asachi" Technical University of Iași, Romania, and Menoufia University, Egypt, blended learning project to innovate pedagogical practices using ITC technology. As a starting point, we advocated to a tertiary education learners' needs analysis with the hope to create a pedagogical model to more efficiently meet those needs. We then engaged in the selection of ICT resources for Blended Elearning Theoretical Fundamentals, in syllabus and courseware materials design and development, in teacher training envisioning ways to creatively put theoretical principles into practice, in devising and developing balanced tests to objectively and coherently assess the communicative goals set. At the same time, we designed, created and judgmentally evaluated the pedagogical materials, supervised technical implementation, and managed the utilization of the system of our end users. The project provided student teachers the opportunity to assume new roles: to become CAL (Computer-Aided-Learning) material designer and developer, script writer, manager and producer of media resources, work flow manager, online tutor, manager of the language learning environment, and mediator to open communication channels with a multidisciplinary team.

The blended-learning pedagogical model implemented combines: (a) Learners' independent work with CAL tasks for developing language skills in a network-based interactive multimedia environment, (b) online tutoring in web portfolios, (c) online interaction with global/local community, (d) online and face-to-face tutoring by CAL teacher-tutors, (e) face-to-face classes with CAL teacher-tutors.

Acknowledgement

We wish to address our thanks to all authors and institutions for the value of their ideas, concepts and information that we used in our project design. All sources are cited in the bibliography.

References

- [1]Crawley, E. F., Malmqvist, J., Östlund, S., Brodeur, D. R., & Edström, K. (2014). *Rethinking Engineering Education: The CDIO Approach*. Springer Science & Business Media.
- [2]Pontes, E., Silva, A., Guelfi, A., & Kofuji, S. T. (2012). *Methodologies, Tools and New Developments for E-Learning*. InTech. 41 Madison Avenue 31st Floor, New York, NY 10010.
- [3]Laurillard, D. (2013). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.
- [4]Melezinek Adolf (1999). *Ingenieurpädagogik – Praxis der Vermittlung technischen Wissens*, Springer-Verlag, Wien New York, 4th edition.
- [5]Armstrong, P. J. (2007). The CDIO Syllabus: Learning outcomes for engineering education. In *Rethinking engineering education* (pp. 45-76). Springer, Boston, MA.
- [6]Rekkedal, T., Qvist-Eriksen, S., Keegan, D., Súilleabháin, G. Ó., Coughlan, R., & Fritsch, H. (2003). Internet based e-learning, pedagogy and support systems. Norway: NKI Distance Education.
- [7]Alonso Amo, F., Manrique Gamo, D., Martínez Normand, L., & Viñes, J. M. (2011). How Blended Learning Reduce Underachievement in Higher Education: An Experience in Teaching Computer Sciences. *IEEE Transactions on Education*, 54(3), 471-479.
- [8]El-Seoud, M., El-Sofany, H. F., Taj-Eddin, I. A., Nosseir, A., & El-Khouly, M. M. (2013). Implementation of Web-Based Education in Egypt through Cloud Computing Technologies and Its Effect on Higher Education. *Higher Education Studies*, 3(3), 62-76.
- [9]Yadav, A., Subedi, D., Lundeberg, M. A., & Bunting, C. F. (2011). Problem-based Learning: Influence on Students' Learning in an Electrical Engineering Course. *Journal of Engineering Education*, 100(2), 253-280.
- [10]Auer, M. E., & Gravier, C. (2009). Guest editorial: The many facets of remote laboratories in online engineering education. *IEEE Transactions on Learning Technologies*, (4), 260-262.

- [11]Conole, G., Dyke, M., Oliver, M., & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. *Computers & Education*, 43(1-2), 17-33
- [12]Anis, H. E-learning in engineering education – General challenges and the Egyptian experience. In: Education in a Changing Environment (ECE) *6th International Conference: Creativity and Engagement in Higher Education*. Greater Manchester, UK: The University of Salford 6–8 July 2011. <http://www.qscience.com/doi/full/10.5339/qproc.2014.wcee2013.4>
- [13]Hussein, A. S., Mohammed, A. H., El-Tobeily, T. E., & Sheirah, M. A. (2009, July). e-Learning in the Egyptian Public Universities: Overview and Future Prospective. In *ICT-Learn 2009 Conference, Human and Technology Development Foundation*.
- [14]Visscher-Voerman, I., & Muller, A. (2017). Curriculum Development in Engineering Education: Evaluation and Results of the Twente Education Model (TOM). In *45th SEFI Annual Conference 2017*.
- [15]E.A.M. van Puffelen (2017). Designing blended engineering courses. *Proceedings of the 45th SEFI Annual Conference 2017*, 1308 - 1312.
- [16]Lattuca, L. R., Terenzini, P. T., Volkwein, J. F., & Peterson, G. D. (2006). The changing face of engineering education. *BRIDGE-WASHINGTON-NATIONAL ACADEMY OF ENGINEERING-*, 36(2), 5.
- [17]Bonk, C. J., Kim, K. J., & Zeng, T. (2005, June). Future directions of blended learning in higher education and workplace learning settings. In *EdMedia: World Conference on Educational Media and Technology* (pp. 3644-3649). Association for the Advancement of Computing in Education (AACE).
- [18]Zutin, D. G., Auer, M. E., Maier, C., & Niederstätter, M. (2010, April). Lab2go—A repository to locate educational online laboratories. In *Education Engineering (EDUCON), 2010 IEEE* (pp. 1741-1746). IEEE
- [19]M. E. Auer, A. Pester, D. G. Zutin, "Open Source Portal for Online Laboratories", *Proceedings of the 4th International Conference on Remote Engineering and Virtual Instrumentation-REV*, Kassel University Press, 2007, ISBN 978-3-89958-278-9.
- [20]Gonçalves, A., & Pedro, N. (2012). Innovation, e-learning and higher education: an example of a University'LMS adoption process. In *WASET, Proceedings of the International Conference in Higher Education* (pp. 1075-1082). World Academy of Science, Engineering and Technology.
- [21]Zafoschnig, A. (2013, September). The development of the new ING-PAED IGIP curriculum into an umbrella for modularised national and regional engineering education curricula. In *Interactive Collaborative Learning (ICL), 2013 International Conference on* (pp. 227-231). IEEE.
- [22]Kinnunen, P., & Malmi, L. (2013, September). Pedagogical Focus of Recent Engineering Education Research Papers. In *SEFI conference* (pp. 16-20).
- [23]Rüütman, T., & Kipper, H. (2015, September). Klagenfurt school of engineering pedagogy by Adolf Melezinek as the basis of teaching engineering at Tallinn University of Technology. In *Interactive Collaborative Learning (ICL), 2015 International Conference on* (pp. 1102-1111). IEEE.
- [24]Salama, M., & Thabet, T. (2010, April). A curricular reform proposal for egyptian computer engineering education ECCE. In *Transforming Engineering Education: Creating Interdisciplinary Skills for Complex Global Environments, IEEE* (pp. 1-10). IEEE.
- [25]Ali, E. A. (2014, July). ICT in engineering educational content delivery: Challenges and opportunities. In *QScience Proceedings (World Congress on Engineering Education 2013)* (p. 4). Qatar: Bloomsbury Qatar Foundation Journals.
- [26]Sedki Riad; Mostafa Kamel (2004). Engineering Education In Egypt: Survey And Assessment. *Proceedings of the 2004 American Society for Engineering Education*.
<https://peer.asee.org/engineering-education-in-egypt-survey-and-assessment.pdf>
- [27]Alebaikan, R., (2010). *Perceptions of blended learning in Saudi universities*. Doctor of Philosophy Thesis, University of Exeter.
- [28]Worldwide CDIO (Conceive--Design--Implement—Operate) Initiative. A Framework for the Education of Engineers. www.cdio.org
- [29]The EUR-ACE® (EUROPEAN ACcredited Engineer) Standards and Guidelines for Accreditation of Engineering Programmes (EAFSG), ENAEE (European Network for Accreditation of Engineering Education), <http://www.enaee.eu/accredited-engineering-courses-html/engineering-schools/accredited-engineering-programs/>
- [30]SEFI Position Paper on Accreditation of Engineering Education in Europe,
<https://www.sefi.be/publication/position-paper-on-accreditation-of-engineering-education/>

- [31] Requirements for accreditation of engineering education programmes, Engineering New Zealand, <https://www.engineeringnz.org/resources/accredited-engineering-qualifications/>
- [32] IEEE Transactions on Learning Technologies (TLT), Special Issue On The Many Facets Of Remote Laboratories In Online Engineering Education, <https://www.computer.org/csdl/trans/lt/2009/04/index.html>
- [33] Michael E. Auer. (2013). Present and Future Challenges in Engineering Education and the Strategies of IGIP. ASEE International Forum. American Society for Engineering Education. <https://www.asee.org/public/conferences/27/papers/8381/view>
- [34] Egypt - Engineering and Technical Education Project (English). <http://documents.worldbank.org/curated/en/154291468237321259/Egypt-Engineering-and-Technical-Education-Project>
- [35] Tempus - e-Laboratories for Physics and Engineering Education. <https://www.elab.edu.eg/local/static/pages/files/SurveyReportELab.pdf>
- [36] e-Learning Competence Center. <http://www.mcit.gov.eg/Training/Affiliate/13>
- [37] Falconer, I., Conole, G., Jeffery, A., & Douglas, P. (2006). Learning activity reference model–pedagogy. LADiE pedagogy guide, LADiE project. http://www.academia.edu/download/3458696/LARM_Pedagogy30-03-06.doc
- [38] Methodologies, Tools and New Developments for E-Learning, <https://www.intechopen.com/books/methodologies-tools-and-new-developments-for-e-learning/>
- [39] IntechOpen, Open Access books, Computer and Information Science, <https://www.intechopen.com/books/subject/computer-and-information-science>
- [40] IntechOpen, Open Access books, Engineering, <https://www.intechopen.com/books/subject/engineering>
- [41] EU Report New modes of learning and teaching in higher education. http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation_en.pdf