Ind4.0

Co-funded by the
Erasmus+ Programme
of the European Union

Master Degree in Industry 4.0

Ind4.0 (610455-EPP-1-MY-EPPKA2-CBHE-JP

DELIVERABLE OF ERASMUS+IND4.0 WP2
D2.5 Description of Methodology and Tools

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Projection Information	
Project Acronym	InD4.0
Project Full Title	Master Degree in Industry 4.0
Project No	601455-EPP-1-2019-1-MY-EPPKA2-CBHE-JP
Funding Scheme	ERASMUS+ KA2 Capacity Building in the field of Higher Education
Coordinator	Universiti Teknologi MARA (UiTM)
Project Website	https://www.ind4-0-eu.my/

Work Package	2 Development of the Ind4.0 MSc Curriculum & VLE
Deliverable:	2.5 Description of Methodology and Tools
Type:	Document
Dissemination level:	Public
Version:	Final
Delivery date:	7/12/2020
Keywords:	Pedagogical framework, Pedagogical tools, pedagogical methodologies, Practicum, Employability, Evaluation, Assessment, Mentoring
Abstract:	D2.5 presents the pedagogical tools and methodologies that the Ind4.0 project will employ for the effective delivery of the MSc programme.

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Date	7/12/2020

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Abstract

This report presents the pedagogical tools and methodologies that the Ind4.0 project will employ for the effective delivery of the MSc program. The key to the process is the description of learning outcomes, objectives, and goals of the MSc program. In addition, methodological principles are analysed through the description of specific activities and evaluation.

1. Methodology and tools: an introduction

1.1. Basic concepts

Methodology is 'a contextual framework' for research, a coherent and logical scheme based on views, beliefs, and values that guides the choices researchers [or other users] make"[1].

It is well known that teaching is not the same thing as learning. Teaching seems to be easy for most people, but learning and making someone learn is a more complex task. For teachers to help students learn, they develop a group of teaching procedures known as **pedagogical methodology**. The pedagogical methodology consists of three elements: instruction, experience, and reflection, as the interaction between teachers and students, form them. As a result, there is a wide variety of pedagogical methodologies. The most important thing is to choose those methodologies that lead to effective teaching.

The key pillars of pedagogical methodology can be summarised to the need of:

- the belief that each student is an individual worth in life and learning and this belief must be demonstrated in practice by teachers.
- The continuous study for teachers to have in-depth knowledge of their science as far as concepts, principles, techniques, and reasoning methods is concerned. In this way, they can establish curricular goals shaping their assessment and instruction.
- The students' knowledge means that teachers must know and take care of their students, the way and rythme they learn, and their life and cultural background. This can lead to better teaching decisions and guidance.
- The knowledge of the art of teaching. Teaching is a procedure that teachers have to simulate, motivate, and facilitate student learning using their extensive pedagogical knowledge base. So, they achieve making students active students, developing confidence and valuable knowledge.
- Making science the way of thinking, teaching students how to reason, investigating problems, and justifying conclusions.
- Scientific and learning growth gives strength to the learning community.

1.2. Defining pedagogical tools

According to the Cambridge dictionary **tool** is "something that helps you to do a particular activity".

In pedagogy, tools can be considered anything that people can use to learn or teach. There are some "traditional" **pedagogical tools** such as textbooks. Still, there is an excellent variety of means, objects, or services that can be considered pedagogical tools depending on specific circumstances.

Technological progress has led to the enhancement of pedagogical tools, which does not mean that traditional tools like textbooks, handouts, worksheets, and hands-on models have been abandoned. New tools like websites and mobile applications have made the teaching and learning process more efficient and accessible.

Pedagogical tools can be divided into those used in the teaching and learning process and those in assessment and feedback.

Starting with the learning process, the first timeless tool is the lecture. A lecture is a traditional tool used to transmit course content to students who usually attend large groups. Academics use lecture as a useful tool to deliver core knowledge to students. However, there is the danger of

[1] *Kara, Helen (2015). Creative research methods in the social sciences: a practical guide. Gergen, Kenneth J., Gergen, Mary M. Bristol: Policy Press. p. 4. ISBN 978-1-4473-1627-5. OCLC 908273802*

making students passive recipients of the information. So, lectures have to become more attractive and interactive to students through the use of new technologies. This direction contributes significantly to the Virtual Learning Environments (VLEs) and the Personal Response Systems that use tests, quizzes, diagrams, videos, and audios to improve students' understanding and participation. Also, lectures are supported by sets of notes that are up-to-date to meet educational challenges and access resources using the Internet.

Additionally, a tool with ascending usage in learning is e-learning. E-learning facilitates and supports students' learning through the extended usage of technology. There are many pedagogical benefits to using this tool. First of all, advanced online communication tools combined with mobile and wireless technologies have boosted synchronous and asynchronous learning. Also, new software dedicated to learning from a distance has been introduced with excellent results. As mentioned above, Virtual Learning Environments promote interactive computer-based learning flexibly, delivering content, and assessment for students and teachers.

Thus, plagiarism detection tools are another tool to enhance learning and assessment. Most of them are parts of VLEs giving instant feedback to students and teachers. In this way, this tool helps them avoid plagiarism, which is an increasing problem due to Internet-based resources' extensive usage.

All the academic work is judged via the assessment and feedback of the students. Students' work depicts the extent to which learning outcomes are met to assure the internal quality and external accreditation of a curriculum and generally a university. So, it is crucial to choose the appropriate pedagogical tools. There is excellent research on such tools, and some of them can be seen below:

- unseen written examinations that is one of the pillars of assessment in most universities
- laboratory/practical/field trip reports, with the primary purpose to be the observation for learning
- analytical calculations, via the development of special software and applications
- multiple-choice questions (especially at lower levels) to test the level of acquired knowledge
- project reports and software developed to support the learning process and gain experience in writing reports and manuals
- drawings (usually CAD)
- portfolios and personal development plans give students the advantage to reflect on and analyse a course's background.
- poster and oral presentations

For the curriculum as general, the development of dedicated educational material and all the means of its production and, more specifically, the connection between this material and the desired learning outcomes constitute a fundamental tool. Educational videos with interactive content for students, wikis to improve cooperation among students, audio guidance from teachers to students in parallel with their study, enriched hypertext in combination with presentations and documents that contain the literature organised in an efficient way to improve learning are only some examples of educational material needed in a curriculum. Last but not least, teacher and student guides belong to the tools required to support the curriculum.

Also, it is generally known that in "practical" science, there is a significant need for learning equipment. Some of this equipment is high-performance computers to support parallel processing for big data analysis, networks of sensors and IoT devices, project management tools, specialised software, and hardware to support teachers and students' needs.

2. Learning design Digital Educational material

2.1 Introduction

The project follows the current trend of the paperless University; as international efforts plan for a full transition of University teaching material from paper to digital form the project also faces a dual role as a publisher and distributor of educational content on the Industry 4.0 topic. Standardisation of the procedures used for designing and developing such content is one of the many challenges.

In Our case, the digital educational material will incorporate pedagogical and learning tecniques since tutors are only digitaly present. It is, thus, of paramount importance to design educational material that enables students to reach the set educational goals in a higly demanding topic such as Industry 4.0. Standardisation of educational content design, development and management requires not only standard processes but a meaningful evaluation of the educational process itself. Questions on how tutors set goals and how the educational content is designed around those goals, how content is consumed by stakeholder and in which way, are some of the key questions answered in this chapter. Current practice relies on guidelines or the transfer of best practices from HOU, a University that relies fully on the distance learning model.

As digital material we consider the construction (artifact) which combines digital content (digital content), a means of disposing of the content (media) for a specific purpose or application (application). If the purpose is educational, then we are referring to Digital Educational Material (DES). For example in a digital educational material the content is the text, the technological means is an application of a superscript while the pedagogical / didactic application is the context in which the application is used (e.g. for additional training in an thematic unit of the MSc course).

2.2 Digital content of educational material

Digital content exists in many types, each of which is stored in a set of different formats (formats). The basic types of digital content are:

1. **Text (Text):** A text is considered a coherent set of characters, words or paragraphs, which may include static and visual material. The text can be:
    - monolithic, which appears in the form of text files (doc, pdf, odt) and allows hierarchical or sequential access,
    - hypertext , i.e. a set of text segments with references (links - links) both between the sections and in external texts and articles,
    - dynamic hypertext (wiki), which is a special category of hypertext and allows all users to modify sections or links, or add new ones.
2. **Audios (Audio):** refers mainly to recordings that are available to the end-user for playback. The audio material is divided into:
    - static audio playback, which requires the audio file to be uploaded to the user's computer and played locally.
    - audio-streaming (streaming), which allows the playback of audio from a remote site (web site).
3. **Static optical material (Graphic):** This is a static digital content based on optics (not verbal or audible) representation. It includes photos, images, maps, diagrams, etc.
4. **Audiovisual material (Video):** This category refers to material that has been produced with the help of audiovisual recording media. It may be:
    - interactive or non- interactive material

- two-dimensional or three-dimensional (2D / 3D animation) material

5. **Moving optical material (Animation):** This category relates to material in a moving image format, which is not considered as audiovisual material. A typical example is an animation that can represent processes or experiments that are difficult to videotape in a real environment. The output file types are similar to those of audiovisual material. It may also take the form of:

- interactive or non- interactive (interactive , i.e., non interactive) material
- two-dimensional or three-dimensional (2D / 3D animation) material

2.3 Development of Digital educational content

The basic types of content can be combined to create complex types of educational content in the light of learning objects (LOs).

The learning objects are autonomous and self-contained segments and pseudo characterised for playback of digital content, and in the educational application. Usually, an LO can be archived as a standalone object in a digital repository, it is mapped to a well defined and small number of learning objectives and includes the learning method of how to reach these objectives. Additionally, a LO is described by a coherent set of metadata, so that it can be searched and located.

The main LO categories are:

Essay (Document)	Hypermedia (Hypermedia)
Supernatant (Hypertext)	Glossary (Glossary)
Dynamic Hypertext (Wiki)	Video lecture (Webcast)
Presentation (Presentation)	Scenario (Scenario) / Guidelines (Guidelines) / Demo (Demonstration)
Sound	Questions Multiple Choice (Multiple Choice Questions)
Image (Image)	Interactive software (Interactive software)
Graph (Graph)	Hypermedia application (Hypermedia Application)
Photo	Game Learning (Learning Game)
Map (Map)	Experiment (Experiment) / simulation (Simulation)
Video	Exercise Software (Software Exercise)
Animation	Case study (Case Study)
Virtual Laboratories (Virtual labs)	Virtual Classes (Virtual Classrooms)

Table 1. Learning Object categories

LOs adopt the IEEE Learning Object standard as well as corresponding standardisation of educational metadata .

2.3 The development process

The process of development of educational material can be treated as a project. Project Management, as defined by PMBOK is essentially the application of knowledge, tools, skills and

techniques during the execution of project activities in order to meet the requirements of the participants.

The implementation of such a project includes the following steps:

1. Informal project start (optional)

2. Project initialisation

3. Design

4. Implementation

That is, to start a project is preceded by an optional and two mandatory steps. This is because according to the principles of Project Management, all the steps that will be taken to implement the project must have been planned in advance in the greatest possible detail.

The project is triggered by an idea, then the goals and the object of the project are defined (Project initialisation). The project is then designed, executed and delivered (Intermediate phases). In the final phases, the project is approved for acceptance by the customer and delivered for use. Each group of phases has its respective inputs and outputs.

The trigger for a project can be demands, problems or opportunities. The first steps before the start of the project define its goals. The results of a project (and therefore when it will end) are directly linked to the objectives that must be set before it begins. Inaccurate goal setting usually also means project failure.

In the case of this project, the design of the curriculum is about setting goals and include:

- Accurate recognition of requirements
- Setting realistic goals
- Maintaining a balance between cost, time and quality
- Adaptation of plans to stakeholders

The requirements are the conditions that the result of the project must satisfy in order to be considered successful. The requirements are mainly determined by the user of the project result. Each project has its own phases. The whole phases of the project is called the Life Cycle of the project.

2.4 Educational material as a product

If we treat the educational material of the Industry 4.0 MSc course as a product then instead of Project Life Cycle the term Product Life Cycle is used. The product life cycle initially contains a business plan (examining the economic and business exploitation of the product), the product cycle that produces the product, and additional phases related to its operation and upgrading. It should be noted that not all educational content development projects have a corresponding product life cycle.

In the case of educational material, a mixture of the two life cycles mentioned above is proposed. It includes the main phases of the life cycle of the project that produces the educational material enriched with phases and processes that treat it as a product.

The life cycle of the educational material takes into account basic parameters such as:

- The educational content

- The educational environment
- The means of interaction
- The type of trainer
- The educational process

We may organise the life cycle of educational material in five stages:

no	Stage	Development cycle processes
1.	Requirement Analysis	1.1 Initialisation (Initiation)
		1.2 Stakeholder Identification
		1.3 Setting Goals
		1.4 Defining Requirements
2	Planning	2.1 Defining educational goals
		2.2 Selection of type and means of diffusion
		2.3 Choice of educational method
		2.4 Selection of degree of interaction
3	Creation	3.1 Content creation
		3.2 Integration into the diffusion medium
		3.3 Pilot Use
		3.4 Internal evaluation
4	Management	4.1 Use
		4.2 Reuse
5	Evaluation / Improvement	5.1 Evaluation 5.2 Design improvements 5.3 Renewal

Table 2. Life cycle description of educational material

The following subsections are followed by an analysis of the individual stages.

The following sections briefly describe this process.

2.4.1 Requirements Analysis

Stage 1 includes four procedures:

1.1 The initialisation of the project: where the initial idea and the general objectives are formulated as well as the needs that lead to the development of the educational material. Initial forecasts are also made for the type of content, the type of VLE, the learning paths and mode of delivery.

1.2 Identification of stakeholders: who will be involved and how.

1.3. Goal Setting: where:

- the target group (distance education, adult education, employed training)
- the complex types of educational content
- the duration of use (e.g. the educational material needs updating in terms of educational content and bibliographic study)
- the needs for support of educational material (technical, scientific, clarifications)

1.4 Specification of Requirements: where the specifications are specified:

- content,
- teaching methodology,
- the technical specifications,
- interaction and interface environment.

2.4.2 Design

Stage 2 includes four procedures:

2.1 Defining educational goals: what are the educational goals and which scenarios will be covered.

2.2 Selection of type and means of dissemination: selection of the type of educational material (electronic, LO, multimedia, hypertext, mixed) so as to serve the educational objectives in the best possible way.

2.3 Selection of educational method: selection of method based on which the educational scenarios will be implemented (knowledge building, knowledge transfer, etc.) At this point the detailed design of the scenarios defined in 2.1 may take place.

2.4 Selection of degree of interaction: optional action concerning educational material that is diffused through the LMS and requires additional special design for the user 's interaction with the system (e.g. feedback on self-evaluation or personalisation of the educational process).

2.4.3 Creation

In stage 3, the creators of the educational material design, develop and deliver the EV according to the educational objectives and the target group. The creation of the content includes four successive procedures:

3.1 Content creation**:** creating content using tools.

3.2 Integration into the VLE: a process involving material that is made available via the VLE and requires additional customisation to integrate.

3.3 Pilot Use: Optional process involving material that is made available via LMS and needs to be checked for proper diffusion.

3.4 Internal evaluation: This stage includes the quality in use evaluation of the educational content and the study of the satisfaction of user expectations (educational goals, expected functions, educational environment). This phase also includes the evaluation in terms of scientific correctness, technical and technological perfection and the investigation of pedagogical - educational completeness. The quality evaluation at this point is defined as Internal Evaluation and concerns the evaluation of the content by selected individuals who are experts in the field of Industry 4.0. This phase aims to investigate dysfunctions in the learning flow, to determine whether the content is at the level of students' abilities and to gather the first reactions of users. The evaluation can be done using structured open-ended and closed-ended questionnaires.

2.4.4 Management

Stage 4 includes all the processes related to the use of educational material and although they are often ignored, they may involve significant costs.

4.1 Use: In special cases the use of educational material includes management tasks in the VLE environment (user account management, folder clearing, on-line and off-line teacher-trainee interaction, etc.).

4.2 Reuse: educational material can be reused if it has the appropriate form (e.g. LO) either as a whole for other educational purposes or in part to compose new educational material.

2.4.5 Evaluation - Improvement

The last phase includes processes related to the evaluation and the improvements that can be made to the educational material after it has been delivered for use. Particularly:

5.1 External evaluation: External evaluation includes the evaluation of the quality of the educational material as perceived by the user, which we define as external quality. External quality is mainly concerned with the quality characteristics of usability, functionality, efficiency and reliability (may loosely be based upon the ISO25000 series standard). At the same time, external quality refers to the quality of interaction or quality of use (quality in use of ISO9126-3).

5.2 Improvement Design: repeat (all or some) of Phase 2 processes once the need for changes in training material has been identified.

5.3 Renewal or Post -evaluation: feedback on the life cycle of educational material. Post-evaluation essentially examines the effectiveness of the educational planning process. The measurement and the qualitative and quantitative interpretation of the internal life cycle metrics lead either to the acceptance of the educational material or to its internal feedback. Identifying past good practices and development and design errors leads to improved life cycle.

3. Basic components of distance education methodologies

3.1 The concept of learning

The concept of learning is divided into:

- Classical (Classic learning): traditional model trainer and trainees commonly used technique transmitting knowledge (knowledge transfer) and requires increased contact between teacher-student.
- Open and Distance Learning (Open and Distance Learning): set any educational activity wherein the instructor-trainee contact occurs mainly electronically.
- Informal learning): is the process in which the instructor is absent and the learner learns on his own.

All three models use ICT (e-learning) to a different degree each. The trainee uses the internet (e- learning , m- learning) to access the educational material, to interact and learn, to collaborate with trainees and trainers. Therefore it could be said that the educational process of distance education should include the possibility for the user / learner to process and construct knowledge using the educational material. In distance education there is a process, the content (which incorporates didactic methods) and the delivery means. The project uses the 3rd method.

3.2 The educational process

The quality standard ISO 19796 -1: 2005 (2005) defines as basic characteristics of the educational product (learning product) the following parameters:

- General Conditions (General Conditions)
- Technical Issues (Technical Aspects)
- Data storage and processing of data (Data storage and Data processing)
- Functions (Functionalities)
- Theoretical Approach (Theoretical Aspects)
- Encoding Information (Encoding of Information)
- Specific modes of presentation (Special modes of presentation)

3.3 The educational content

The educational material (educational material or learning material) is defined as (teaching material) that in a process of creative learning (self-learning) is used to teach the learner. The educational material in distance education is much more complex than a simple book and is defined by different, and distinct levels:

- Content (Content): which contains text, graphics, interactive objects (text, graphics, interactive objects).
- Presentation (Presentation): wherein specified content characteristics such as (Format, fonts, colors, images) and the information encoding (Encoding of information).
- Structure (Structure): defining the manner in which educational material divided into educational units and how the user / student navigate and interact with them.
- Educational context (Context): defines the form of educational content in relation to the target / use group (workplace, training, technological training, learning) and prior knowledge.
- Pedagogical features (Pedagogy): where defined pedagogical strategies used for the use and organisation of content.

3.3.1 Content

The educational material in terms of content presents the following characteristics that enhance the understanding of scientific knowledge, encourage and assist the student in the development of critical thinking and rely on the interaction of science, technology and society.

The educational material in terms of content is divided into five (5) main categories that constitute the superset of the particular forms of educational content:

Text	1. Essay (Document) 2. Supernatant (Hypertext) 3. Dynamic Hypertext (Wiki) 4. Presentation (Presentation) 5. Hypermedia (Hypermedia)
Image	6. Photo 7. Map (Map) 8. Graph (Graph)
Video	9. Animation 10. Video lecture (Webcast)
Application	11. Game (Educational Game) 12. Simulation (Simulation) 13. Virtual Lab (Virtual Lab) 14. Hypermedia Application (Hypermedia Application)

Table 3. Categorisation of educational content

3.3.2 Presentation

The presentation refers to the way in which the educational material is presented to the user and refers to formatting features and technical characteristics of the main categories of content. The technical and morphological characteristics are easily measurable and are a key parameter for the quality of the educational material. They concern the definition of specifications for the categories of content.

3.3.3 Structure

The correct structure of the text does not in itself guarantee its suitability for distance learning. The organisation of the text should display features, which involve the learner in interaction with him and facilitate the identification of specific parts of the text, depending on the aspirations of the learner. In general, the educational content should have some general characteristics that are summarised in the following table:

• Purpose	• Table of Contents
• Expected results (Learning objectives)	• List of images

• Key concepts • Introduction / introductory remarks • Introductory exercises • Prerequisite knowledge	• List of symbols • List of tables • Study scenarios
• Summary / summary • Guide for further study • Bibliography	• Index of terms • Knowledge checklist • Reminders

Table 4. Educational content's structure for use in distance education

3.3.4 Educational context

The definition of the educational framework refers to the context of use of the educational material and can be:

- Adult education with the method of Open and distance education.
- Education
- Training

The type of educational framework also determines the form of the educational material.

3.3.5 Pedagogical characteristics

Pedagogical characteristics are determined by learning theories which in essence are a theoretical reflection of the way in which the learner learns and determine the educational goals of the educational material. Then the most important ones are analysed below.

3.3.5.1 The Bloom classification

For the definition and formulation of teaching objectives in the cognitive domain in the Educational Planning, the taxonomy (taxonomy) of Bloom (1956) includes the following levels:

- Learning / Knowledge : recall data, facts or information.
- Understanding / Comprehension : understanding and explanation of the meaning.
- Application / Application : problem solving, use of a concept to new situations, application of knowledge
- Analysis / Analysis : Finding components of a totality, understanding of organisational principles.
- Synthesis / Synthesis : new structure assembled from different elements.
- Assessment / Evaluation : formulation of value judgments based on criteria.

3.3.5.2 The Gagne teaching design model

In instructional design models (Instructional Design, ID) included in the model of Gagne, Briggs and Wager (1992), also known as "Teaching Design Principles» (Principles of Instructional Design).

This model consists of nine instructional events, on which the teacher can rely to design a lesson. These steps follow the following sequence:

1. **Ensuring attention:** the **learner's attention** should be ensured in order to have appropriate conditions for learning. This is done by arousing interest, motivation and curiosity, providing basic information that is valid.

2. **Informing the learner about the objectives:** the teacher informs his students about what to expect and prepares them to receive information, specifying what to expect and what is the relevance of the subject to be taught.
3. **Challenge of recalling prior knowledge:** access to pre-existing knowledge is a key factor in the process of learning new knowledge. The mobilisation of existing cognitive structures and patterns facilitate substantive learning.
4. **Presentation of the new content:** the new material is presented with the aim of course of obtaining and learning the information.
5. **Provide guidance to the learner:** the teacher guides the student in learning using workshops, examples, questions and other techniques, such as hints and auxiliary ideas, in order for the student to semantically codify the new content.
6. **Posting answers:** the learner answers questions on what has been taught, so that through his performance his learning is confirmed. Practicing students can also be done through a practice of a skill, participation in a discussion, a group activity, a written answer, making a work of art, etc.
7. **Providing feedback:** at the end of each activity the teacher gives immediate feedback (feedback) learner, correcting and enhancing its performance
8. **Performance appraisal:** with independent practice the apprentice applies what he has learned. The teacher can thus check if the learning objectives have been achieved and to what extent.
9. **Enhancing retention and transfer:** the acquisition of a cognitive field presupposes the application of knowledge to real-life situations. The teacher asks the learner to generalise what he has learned and apply it to new activities and new contexts , in order to be preserved in long-term memory.

3.3.5.3 The model of Kolb

Kolb's model is a four-step learning process:

1. observation
2. thought
3. feeling
4. act

which is followed by a description of the four different learning styles used by individuals: Divergent, Assimilator, Convergent and Adaptive.

3.3.6 Learning styles

Pedagogical features mentioned in the pedagogical theory of learning and teaching methodology adopts instructional materials, the ability to support multiple different teaching approaches (teaching, investigation, discovery) and different learning styles (learning style).

According to Honey & Mumford, in terms of learning style the learner is characterised as:

- Activists (Activists)
- Reflective (Reflector)

- Theoretical (Theorists)
- Pragmatic (Pragmatists)

According to the learning cycle of Kolb, the learning styles are:

- Pragmatic convergent (Pragmatists or Convergers)
- Theoretical or assimilates (Theorists or Assimilators)
- Activists or Diefthetites (Activists or Accommodators)
- Reflective or diverging (Reflectors or Divergers)

Based on this design, multiple perspectives and representations of each concept were developed, such as theoretical presentations, examples, exercises, activities that use real-time simulations, material search activities, group work, with the aim of being the primary material to support alternative educational approaches. different learning styles.

It should be noted that people learn with all four learning styles mentioned, but tend to prefer one of them. The ideal learning environment contains all styles. This can be achieved as follows: the cycle can begin with the learner's involvement in specific experiences and continue with the reflection of these experiences. The trainee seeks to find the meaning of new experiences. The learner then applies the semantic pattern he has acquired to create a logical conclusion, an abstract idea of things. Finally, he experiments with similar problems which result in new experiences.

4. Learning Outcomes

4.1 Defining Learning Outcomes, Objectives, and Goals

The Industry 4.0 Master degree aims to train Theoretical, Natural, Engineering, Computer Science, and Information Technologies graduates to address the new challenges posed by the ever-increasing globalisation in production, manufacturing, and service provision. These challenges are primarily rooted in technological know-how and a high degree of automation using modern production paradigms that incorporate individuality, flexibility, and reconfigurability. The growing interconnectedness and rise in cooperation between man and machine change how products are produced and lead to entirely new products and services. These challenges are met by the increasingly complex interconnections between machines, raw workpieces, finished products, transport units, and computers made possible by the Internet of Things, Cyber-physical Systems, Social Networks, Cloud Computing, Big Data Analytics, and Cognitive Computing: a new industrial revolution named Industry 4.0.

In this context, the Master's Programme encompasses the different sources of knowledge and experience required by Industry 4.0. It combines the diversity of expertise of leading European Universities. It offers education oriented to a multi-disciplinary understanding through experts from complementary fields in a research-oriented environment with close cooperation with the industry.

The program is structured to provide both fundamental knowledge of the discipline (core courses) and specialisation (orientation courses) for vertical and horizontal value-creation chains of four key industries, namely Manufacturing, Agriculture, Aquaculture, and Pervasive Health. These are the main objectives of the program

The program has a duration of 18 months for full-time students and 24 months for part-time students.

Courses are arranged as a mix of theory and application in project-led education using a blended mode of delivery (face to face and distance learning training). Placements at key industrial players are also offered as an option at the later stages of the program. Students also can perform research by writing a dissertation that will help them further develop the critical skills needed for a career in Industry 4.0.

The program is developed in such methodology so as its goals and outcomes to be SMART, according to George Doran (1981)[2]. This means that the program's purpose is Specific, Measurable, Achievable, Relevant, and Time-bounded. Specific means to determine with clarity and accuracy the desired result, measurable in the sense that it can be ascertained the achievement of the goal after the end of the program, achievable based on the structure and resources of the program, relevant to the general purpose and other objectives, and finally time-bound, in the sense that the specific targeting is not ambitious and beyond time limits of educational intervention.

As already mentioned, the goals are formulated at three levels: knowledge, skills, and attitudes or, in any case, receive the expected results in terms of knowledge, qualities, abilities, attitudes, and behaviours.

4.2 The Learning Outcomes of the Ind. 4.0 course

The primary learning outcomes of this program can be summarised in the next table:

[2] *Doran, G. T. 1981. There's a SMART Way to Write Management's Goals and Objectives, Management Review 11/71.*

- to **learn** the principles of digitalisation and enabling technologies that lead to what is known as Industry 4.0,
- to **understand** the drivers and enablers of Industry 4.0,
- to **learn** the principles of Smart Factories, Smart cities, smart products, and smart services,
- to able to **outline** the various systems used in a manufacturing plant and their role in an Industry 4.0 world,
- to **understand** the role of data, information, knowledge, and collaboration in future organisations,
- to **learn** technologies, protocols, and tools for applying IoT in processes and services,
- to **learn** how these technologies can make processes swifter, increase productivity, and improve the efficiency of industrial organisations,
- to **create** ecosystems for improvement and innovation, with clients, suppliers, technology partners, and other stakeholders,
- to **incorporate** new strategic tools into business models,
- to **implement** a project for the digital transformation of a process, area, or department in Manufacturing, Agriculture, Aquaculture, and Health.

Table 5. High level learning outcomes of the Industry 4.0 course

Additionally, the program trains students to acquire communication skills via project and practical work. Furthermore, the need for research on innovative products and services improves students' entrepreneurship and enterprise skills, and their intellectual property awareness is enhanced. The curriculum and structure educate students on sustainable development, think critically and effectively, and be more creative and collaborative, especially problem-solving. Therefore, the main goal is to prepare the future workforce for all the aspects of the new industrial revolution named Industry 4.0.

5. Application

5.1 Methodological Principles

5.1.1 Pedagogic models

Five primary pedagogical models determine the design of a Master Degree in Industry4.0. In the first model, Piaget argues in the theory of constructivism that the building blocks of learning are cognitive structures. Dewey and Vygotsky analysed social constructivism in more detail, arguing that learning requires dialogue between students and teachers, as it is a social activity. Dewey describes constructivism through the example of the maps. On a map of unknown geographical areas, there are references to the most important landmarks.

Similarly, students need a similar framework to maps to understand a topic, improving their knowledge. The mental organisation is essential for storing and retrieving information, as students must create bonds with each other, learning new cognitive structures. According to the above, it is argued that students entering the classroom have prior knowledge that affects how new knowledge is acquired [3]. This model can be successfully applied when teaching is done online. However, technology's role should support social discussion tools, such as chat forums and e-mail. Unlike the university's classroom environment, where there is a social activity, the same does not apply to online courses, where teachers need to be more organised. They will also have to decide what tools to use to develop the necessary communication. Furthermore, students can attend online courses as many times as they choose. Thus there is a greater degree of freedom in contact with the other students and the teacher during the week.

Resource-Based Learning (RBL) is the second model. The amount of raw material on the Internet can only be compared to the Library of Alexandria. However, the difference between them is that the Internet does not contain all the known knowledge on all available topics. There is a large amount of information that pre-exists before the Internet, and its digitisation has not yet begun. The volume of information and knowledge currently available on the Internet is vast. Through the new knowledge that students acquire from the Internet, they can enrich any lecture data and research their work. The RBL model helps teachers assign more exciting and relevant tasks to students, who no longer need to be limited to textbooks. They can use the Internet and other online resources to search for more information about their work. Finally, students need to be informed about applying critical thinking on the data from the websites they visit, encouraging students' curiosity and research skills, involving them in active learning[4].

The third pedagogical model is **collaborative learning**, where Dewey states that the key to real learning was planned activity in social settings[3]. Group exercises are an excellent tool for teaching team building and communication skills and proving team synergy in problem-solving. Students generally understand the subject better, promoting and defending their views by listening to other team members' opinions. Students also learn the importance of roles and negotiators, which, although beyond the specific subject of a particular lesson, are essential elements of discipline. The online environment supports group communication, so teams communicate with each other involving trainers. Role simulation is highlighted through collaborative learning. The perspectives that students see are many and varied. Simultaneously, they learn a lot more concerning the assignment's technical aspects[5].

[3] *D.C. Phillips, D. C., and J.F. Soltis, Perspectives inLearning, Teachers College Press, New York, 2004.*
[4] *M. Weller, Delivering Learning on the Net: The Why, What, & How of Online Education. Kogan Page, London, 2002.*

[5] *S. Naidu, "Designing and Evaluating Instruction for ELearning", In: P.L. Rogers, Designing Instruction for Technology-Enhanced Learning, Idea Group Publishing, Hershey (PA), 2002.*

The fourth model of online course design is **problem-based learning (PBL)**. A fun way to expand students' knowledge are problems that are not adequately defined. The method to achieve this is to make abstract concepts more real. Problems tend to be precise; students usually have more motivation to work efficiently on such projects. They further improve their problem-solving skills by often making many realistic assumptions that apply to them. Students use what they know to fully define the problem and find the solution, which can sometimes be more than one. It is also suitable for the online environment because exciting problems can be more easily conceived and solved with information from the Internet[6].

Problem-based learning has been introduced in some engineering departments as it has been found that in this way, the learning outcomes of the students are improved. Students' motivation is better, and they gain independence in learning by understanding the subject more deeply. In this type of learning, problems act as a driving force for learning. It differs from "problem-solving." Students acquire problems before acquiring relevant knowledge and develop the necessary expertise and problem-solving skills through their solutions. When solving a problem, the student has already gained experience and improves his specific field experience through the solution.

The fifth pedagogical model **is narrative teaching (NBT).** This term refers to the teaching of stories or the sharing of experiences. The field is relatively new, and as changes in technology and laws are rapid, digital criminology benefits from the telling and true "war stories" by educators and students. The classroom experience is more than a book allowing a look at everyday life's practical and ethical issues. The narration also applies effectively to an online lesson. This is aided by media tools such as audio, video, and animation, elements that improve a story's telling. Providing an intimate, realistic environment helps to make a subject more exciting[7].

5.1.2 Project-based learning

Through project-based learning, students acquire skills based on knowledge from various areas to apply to real-world problems. Existing knowledge is further enhanced by providing a context to the theory[8] [9].
The projects can be an individual or group, with a duration from one day to one year. Students should use the new knowledge they will acquire to find solutions to the new work environment's problems.

5.1.3 Work-based learning

Work-based learning (WBL) in a university engineering department can be considered as learning for work. Undergraduate students usually undertake the WBL, which is part of their degree in work experience modules. For teachers, integrating WBL into a degree program as teaching is a significant challenge, as it is part of the overall degree evaluation. The duration of the work

[6] *R.M. Felder, and R. Brent, "The ABC's of Engineering Education: ABET, Bloom's Taxonomy, Cooperative Learning, and so on", Proceedings of the 2004 American Society for Engineering Education Annual Conference &Exposition. Retrieved November 20, 2020, from https://www.engr.ncsu.edu/stem-resources/legacy-site/education-related-papers/*
[7] *M. Weller, Delivering Learning on the Net: The Why, What, & How of Online Education. Kogan Page, London, 2002.*

[8] *Crawford, A and Tennant, J (2003) A Guide to Learning Engineering through Projects. Retrieved November 20, 2020, from http://www.pble.ac.uk*
[9] *Project Squared: A Guide to Project Work in Electrical and Electronic Engineering (2003), Retrieved November 20, 2020, from http://www.eee.ntu.ac.uk/pp/ .*

experience can be from a few months to a whole year[10]. Many students believe that the WBL has improved skills like work under pressure, communication, timing, interpersonal and reflexive skills). They also think that they can apply this theory to real-life tasks. Teachers believe that WBL significantly improves students' motivation and general skills, and their specific technical skills. Employers, when students have already graduated, recognise the specifics[11] [12].

A successful work placement scheme includes the following six stages:

Prepare the placement. Building links with the industry takes several years. In some engineering departments, a particular staff member contacts the employers and informs them about the placements' possible benefits.

- *Cooperation between the stakeholders of the process*. There should be a handbook setting out responsibilities for students and companies. It is also useful to have a visiting tutor who will monitor all members' processes and communication.
- *Health – safety issues*. Health and safety legislation needs to be researched by universities. Businesses should comply with the law to minimise the risks to students. It should be noted that universities should also adhere to the law[13].
- *The way of preparation*. Students should be informed about the benefits of job placements and the formal requirements that exist in the workplace. It is also necessary to take courses to help students write their CVs and complete the application forms.
- Contact with the student. Students should contact the university to discuss any problems they face in the workplace.
- Evaluation. The evaluation process should be simple. Students should be encouraged to evaluate their progress. They could complete a personal development diary. Additionally, if a student carries out project assignments, the project report is part of the assessment.

5.2 Teaching Methods Activities

5.2.1 Structure

The Master's Programme curriculum provides theoretical and practical training for students through critical subject areas, optional subject areas, and seminars. At the final stages, students will choose between external placements or a public defense of the final project (Master Thesis).

The Course has 90 ECTS (18 months) divided into three course-based semesters and 1 Master thesis/Placement semester. An ECTS unit corresponds to 30 hours of study according to the European Credit Transfer System. Each Semester allows 30 ECTS to be gained. The first two semesters are based on courses, lab exercises, and laboratory sessions that provide the basis for the specialisation pathway each student can choose in the third Semester. There are four specialisation pathways, each one related to an application area, namely Industry 4.0 for Manufacturing, Industry 4.0, Agriculture 4.0, Aquaculture 4.0, and Pervasive Health services.

[10] *Quality Assurance Agency (2001) Code of Practice for the Assurance of Academic Quality and Standards in Higher Education. Section 9: Placement Learning, Gloucester: The Quality Assurance Agency for Higher Education.*

[11] *Engineering Subject Centre (2005) Guide to Industrial Placements, Loughborough: Engineering Subject Centre.*

[12] *New Engineering Foundation (NEF) (2007) The Path to Productivity: The Progress of Work-based Learning Strategies in Higher Education Engineering Programmes, London: NEF.*

[13] *CVCP (1997) Health and Safety Guidance for the Placement of HE Students, London: CVCP.*

The curriculum will offer four types of courses:

1. Fundamental courses: they are compulsory for all specialisations and are taught in the 1st and 2nd Semesters. They provide core knowledge for the various Industry 4.0 topics.
2. Elective courses for all specialisation pathways. Students can select such a course from a list of options for gaining more profound knowledge on a specific topic. They are provided in the 1st and 2nd Semesters of the 1st year of the Master's Course.
3. Orientation courses, compulsory for a specialisation pathway. These are core courses for a specific path and are offered in the 3rd Semester.
4. Orientation Elective courses for a specific specialisation pathway that are offered in the 3rd Semester.
5. The final thesis or placement covers the 4th Semester of the Course.

For each one of the four specialisation pathways, the curriculum will offer 30 ECTS for fundamental courses

- 10 ECTS for elective courses
- 20 ECTS for orientation courses
- 10 ECTS for Orientation Elective courses
- 20 ECTS for the Master Thesis/Placement

The course is organised in four semesters as follows:

1st Semester: it offers courses that are compulsory for all specialisation pathways covering introductory topics in Industry 4.0, Computer Networks and Interoperability, Internet of Things, Cloud Computing and PLC Systems and Industrial Control.

Students must also choose courses from the 1st Semester's elective courses covering :

- Software as a Service
- Cyber Security
- System Analysis and Optimisation
- System automation
- Operations Management
- Supply Chain Management
- Horizontal & Vertical System Integration

2nd Semester: more advanced topics are covered through 4 compulsory courses in Cyber-Physical Systems, Big Data Analytics, Human-Machine Interaction, and Autonomous Robots.

Students must also choose courses from the list of 2nd Semester's elective courses covering :

- Artificial Intelligence
- 3-D printing
- Augmented Reality
- Cognitive Computing
- Safety and Quality
- New Business Models

3rd Semester: it includes class and project-based courses with topics specific to the four application areas of the Course, such as :

- Robotics
- Additive manufacturing
- Sensors and actuators
- Real-time control

- Configurable operations
- Horizontal and vertical integration, Simulation
- Embedded systems
- Personal health systems
- Human-robot interaction
- Artificial Intelligence
- Energy efficiency and power management in Industry 4.0 systems
- Mobile/wireless health
- IoT-enabled biosensors
- Health Information
- Management and Pattern recognition
- Shared knowledge ecosystems for optimised farming and Precision agriculture

4th Semester: the last Semester is dedicated to the Master Thesis, a project-based dissertation in one of the curriculum's application areas. Alternatively, students may choose an essential industry placement in one of the curriculum's application areas.

5.2.2 Mode of delivery

Emphasising on flexibility, the program uses a blended model of delivery combining classroom-based teaching methods with online learning. Advanced Learning Management systems will supplement education, combining online teaching with regular face-to-face meetings with academic staff. This might also involve evening seminars or weekend conferences to make it as accessible as full-time workers or international students. Attendance of these meetings isn't always a requirement, depending on the Course.

This model gives students the ability to meet each other and their tutors in person throughout the program. Students will be provided with various learning materials that can be used to study from home: course material, set books, audio, and video material, software specially prepared for distance learning. They will be continuously supported by the Academic Staff and will be contacted regularly.

5.3 Evaluation Types and Techniques

5.3.1 Evaluation of Students' Performance in Modern Learning Environments

Undoubtedly, at the dawn of the 21st century, evaluating the students' performance is one of the most important modern issues of reflection and research of the educational and academic community[14].

Globally, an increasing number of surveys recognise that student evaluation plays an essential role in the educational process and is a dominant criterion for its general designation as successful or unsuccessful [15]. In modern pedagogy, evaluating students' performance is considered a fundamental process directly related to the teaching process (Figure 1)

[14] *Anderson, S., Bauer, F. & Speck, W. (2002). Assessment Strategies for the On-line Class: From Theory to Practice. New Directions for Teaching and Teaming. Jossey-Bass: San Francisco: Wiley.*

Darling-Hammond, L. & Adamson, F. (2010). Beyond basic skills: The role of performance assessment in achieving 21" century standards of learning. Stanford Center for Opportunity Policy in Education, Stanford University

Stiggins, R (2004). New Assessment Beliefs for a New School Mission, Phi Delta Kappan, 86(1), pp. 22-27.

[15] *Eurydice (2004). The teaching profession in Europe: profile, trends and concerns. Keeping teaching attractive ïorthe21StcenturyAnKeytopπsmeducationmEurope,3,PPA-99.BruSSeL*

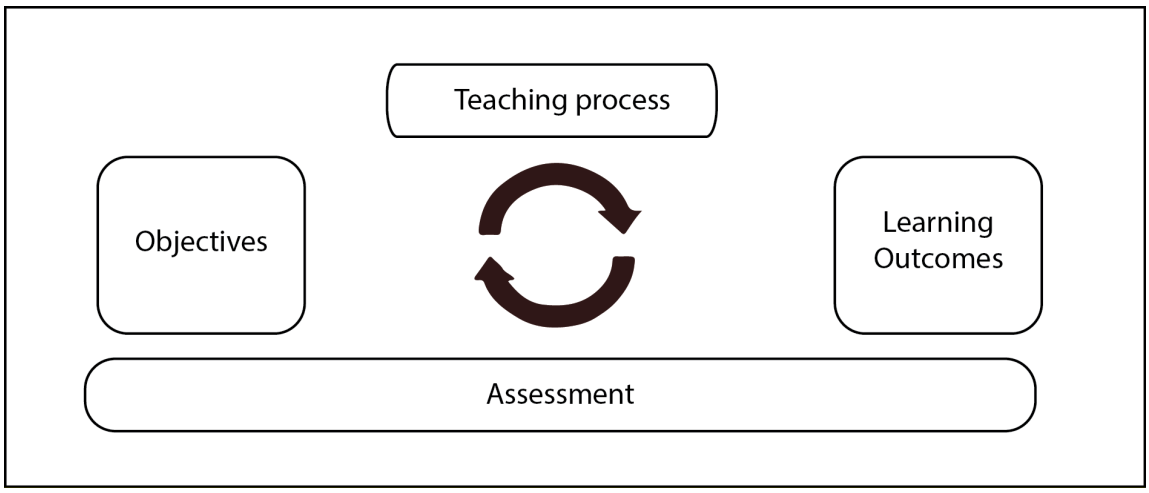

Figure 1 Assessment as a feedback mechanism

By carefully studying Figure 1, we observe that students' assessment diffuses the entire teaching process, controlling the process of achieving the intended objectives and correlating them with the resulting learning outcomes. In this context, assessment has an essential role as a feedback mechanism for both students (continuous monitoring of their learning progress, detecting their weaknesses through strong metacognitive skills, such as self-regulation).

The pedagogical value and dynamics of student assessment derive from the multiple roles it plays in contemporary teaching[16]. In more detail, the evaluation of the students contributes:

- in determining the degree of achievement of the teaching objectives and in the planning of the next stages of learning by the teacher and the instructor of the educational process (instructional designer),
- in the continuous feedback of the teaching practice with the ultimate goal of improving its quality and increasing its effectiveness,
- in the investigation and evaluation of both the individual and group action of the student and the abilities, skills that he develops during the teaching process,
- to strengthen the active participation of students in the assessment process while cultivating skills of self-assessment, peer-assessment, and reflection,
- in the detection of learning weaknesses and shortcomings of students with the ultimate goal of feedback to students and the design of appropriate teaching interventions to improve the learning process,
- to strengthen the self-confidence and self-esteem of the students and to develop metacognitive skills through the control and management of their learning (self-assessment, peer-assessment),
- the quality upgrade of the educational process as a whole, which aims to strengthen and encourage students and to create learning incentives.

NCTM (2000). Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers ofMathematics

OECD and UNESCO Institute for Statistics (2003), Literacy Skills for the World of Tomorrow - Further results from PISA 2000, Pans, OECD

[16] *Corcoran, A., Dershimer, L. & Tichenor, S. (2004). A teacher's guide to alternative assessment: Taking the first steps. The Clearing House, 77(5), pp. 213-216.*

In modern learning environments:

Teachers apply well-designed learning scenarios based on innovative pedagogical approaches (e.g., collaborative, exploratory learning, etc.).

Educational-digital technologies are used to achieve the desired goals of the Learning Society.

The effective utilisation-integration of appropriate digital technologies in well-designed learning scenarios:

a) contributes to the cultivation of cognitive, metacognitive, and communication skills, which will allow each learner to become an independent thinking and active citizen of the 21st century
b) enriches the learning process by contributing to the maximisation of the expected learning outcomes
c) contributes to the creation of the right environment for the conduct of scientific methods, etc. [17].

In recent years, modern approaches to learning, combined with changing educational goals and the dynamic rejection of educational technologies in the learning process, have focused on educational research. There is also a strong need to redefine and clarify the purpose and objectives it serves in these environments, as well as its content itself [18].

Simultaneously, they led to the emergence of new trends, which demonstrate a modern approach in the field of performance evaluation, the basic principles of which are:

- Learner performance evaluation is linked to the teaching process, recognised as a valuable tool for both teachers and students, as it enriches the learning process itself [19]
- Students' evaluation is based on assessing their performance based on clearly formulated criteria derived from the learning process's general and specific objectives and are communicated promptly to the students.
- Students' assessment evaluates both learning outcomes and the complex learning process itself (grid of student-teacher interactions and between students and material).
- Assessment of students concerns each learner's performance and the progress he achieves concerning his previous performance. [20]
- Students are assessed through complex activities. [21]

[17] *Barton, R. & Haydn, T. (2006). Trainee teachers' views on what helps them to use information and communication technology effectively in their subject teaching. Journal of Computer Assisted Learning, 22, pp. 257–272*

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E. & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. Computers & Education, 59(2), pp. 423-435.

Valtonen, T., Pontinen, S., Kukkonen, J., Dillon, P., Vaisanen, P. & Hacklm, S. (2011). Confronting the technological pedagogical knowledge of Finnish net generation student teachers. Technology, Pedagogy and Education, 20(1), pp 1-16

[18] *Stiggins, R, Arter, J., Chappuis, J. & Chappuis, S. (2007). Classroom Assessment for Student Learning. Doing it Right-Usmg it Well. Portland, Ore, ETS Assessment Training Institute.*

[19] *Johnson, R, Penny, J. & Gordon, B. (2009). Assessing performance: designing, scoring, and validating performance tasks. Guilford Press*

[20] *Spada, H., Meier, A., Rummel, N., & Hauser, S. (2005). A new method to assess the quality of collaborative process in CSCL. In T. Koschmann, D. Suthers, & Chan, T. W. (Eds.), Proceedings of the CSCL 2005 (pp. 622-631). Mahwah, N.J: Lawrence Erlbaum Associates*

[21] *Wren, D. (2009). Performance Assessment: A Key Component of a Balanced Assessment System. Report from the Department of Research, Evaluation/and Assessment, Research Brief (2), Virginia Beach City Public Schools*

- The active participation of the students in the assessment process is encouraged. The students are encouraged to acquire more and more skills of self-assessment, hetero-assessment.
- The particular characteristics are taken into account in the assessment (e.g., cognitive learning style background, etc.).
- The assessment process is carried out with various techniques (quantitative and qualitative data), depending on the learning process's objectives and content.
- The assessment results are communicated to the students and used in their favor (feedback, acquisition of cognitive skills through proper control and management). [22]

According to the above principles, there has been a continuous effort at the international level to clarify and delimit students' evaluation concepts in modern learning environments. The use of various definitions in international literature, often complementary and interdependent, demonstrates the field's complexity and the need for its conceptual clarification.

Although the literature review shows the lack of a universally accepted definition, the existing approaches show a strong tendency to capture the modern dimension of evaluation's basic principles. Taking this trend, we define as evaluation of students' performance in contemporary learning environments the systematic process of data collection and analysis to assess students' knowledge and skills (always depending on the intended teaching objectives set). The data collected concern both the students' products and the way (process) through which they are made.

In the international literature and practice, this new trend is mainly attributed to the term "performance assessment" [23]. Alternatively, the terms are used: a) "alternative assessment", a term that arose from the need to differentiate with the psychometric model of performance evaluation of the previous century (focusing on the assessment of cognitive achievement) and b) "authentic assessment", a term that emphasises performance appraisal through authentic everyday activities.

In modern pedagogy, the evaluation of students' performance:

- It is considered a dynamic learning tool, as it is connected to the teaching process and aims to assess the expected teaching objectives' level of achievement.
- Its primary goal is to create expectations and to involve students in the evaluation of their efforts actively.
- Its main goal is the students' feedback and the cultivation of strong metacognitive skills through the control and management of their learning (e.g., self-regulation, self-assessment).
- Focuses on assessing "What they know", "What they understand," and "What students are capable of doing".

It is not limited to evaluating the school performance (i.e., only in cognitive nature characteristics) but includes a data set (empirical, psychological, social). These data allow the teacher to form a complete and clear picture, both of the learner's personality and the context under which the skills have been developed and demonstrated while allowing appropriate teaching interventions to improve the expected learning results.

[22] *Andrade, H. & Valtcheva, A. (2008). Promoting Learning and Achievement Through Self-Assessment. Theory Into Practice, 48(1), pp. 12 -19*

[23] *Wren, D. (2009). Performance Assessment: A Key Component of a Balanced Assessment System. Report from the Department of Research, Evaluation/and Assessment, Research Brief (2), Virginia Beach City Public Schools*

5.3.2 The Pedagogical Dynamics of Electronic Assessment

Digital technologies have transformed current educational practices, offering innovative and effective answers-solutions to students' evaluation. The result of this transformation is the growing rejection of e-Assessment in everyday educational practice [24].

Electronic Assessment is increasingly accepted by the educational community. It simplifies the time-consuming and tedious procedures associated with designing, creating, making available (to students) various assessment tests, and automating the grading process.

The Electronic Evaluation is carried out through information systems (software) that automate the process of evaluation tests and are found in various forms, such as:

- stand-alone information systems, which are installed and operated locally on the user's computer (teacher-student)
- web-based information systems, which are installed on a central server and only need an internet connection and a browser to access them
- information systems integrated into Learning Management Systems (LMS based), which are a functional part of the Learning Management System used by the teacher

The electronic assessment software has a very user-friendly and attractive interface for the user (teacher-student), providing various multimedia material and clear and understandable instructions for the functions they support.

Depending on how sophisticated the electronic assessment software is, it can effectively support the teacher's work by providing a range of features, such as:

- Design and development of types of objective type questions (e.g., matching, multiple-choice, divergent form, etc.), resulting in the most complete and detailed automatic grading of a large number of students.
- Support for the creation of a variety of questions accompanied by multimedia material (e.g., audio and video files, etc.), offering students interesting, engaging and interactive experiences.
- Automatic creation of various tests. Having a question base, in most applications, facilitates the teacher and speeds up the time-consuming topic selection process.
- Design, development, and distribution of adaptive tests to students. In adaptive tests, the choice of questions is not static but is adapted-based on the learner's performance on previous questions. This software help teachers to define rules for navigating questions based on teaching strategies. In essence, adaptive tests are dynamically adapted to the learner's particular characteristics and development during the assessment test.
- Providing instructions, hints, and personalised feedback to the learner to find the right answer. The input may include: a) reference to additional learning resources (theory, examples, exercises, multimedia material to fill in gaps and weaknesses, b) providing encouraging feedback, advice, etc.
- Scheduled, automatic distribution, and delivery of the evaluation tests (e.g., test, concept map) in a specific period. The teacher determines the educational process at a particular point in time, while its completion time is scheduled.
- Automatic production of reports with static analysis of results. The system database holds essential data such as the scores in the individual tests (e.g., in the individual tests), the average performance of the students per question, the average score per

[24] *Wu, C, Chanda, E. & Willison, J. (2014). Implementation and outcomes of online self and peer assessment on group based honours research projects. Assessment & Evaluation in Higher Education, 39(1), pp. 31-37.*

student in all the individual assessment tests, as well as the total score, the start and completion time of the test per student.

The capabilities provided by the software of electronic evaluation for correction of the evaluation tests facilitate the teacher's work as it offers significant advantages compared to the traditional-printed form of the evaluation tests. The most important of these are:

- Simultaneous evaluation of many students in a wide range of subjects, always related to the learning objectives
- Reduction of the total time of conducting the evaluation tests (e.g., tests, rubric evaluation of the concept map), correction and announcement of the results
- The evaluation results are immediately available to the teacher and the student
- The way of examination is more attractive for the student. The ease of use of the environment, the ability to respond to answers (e.g., instant feedback), the ability to navigate through questions, new types of questions (e.g., games, matches, etc.) the integration of multimedia material keeps high levels of the learner's interest and strengthens learning motivation

The ability to keep records and automate the management of exams helps the teacher's work. The assessment data are presented in a simple, understandable, and friendly way through the tool, interpreting the students' behaviour. In this way, the teacher can have a clear picture of the cognitive level and the students' learning course; he can identify their weaknesses and redesign his teaching process to achieve the expected learning outcomes.

5.3.3 Assesment techniques

This section will list the best-known techniques for assessing students ' performance, how teachers in modern learning environments apply them, how and which of them are supported by digital technologies, and what opportunities they offer to teachers and students.

The most common and popular assessment techniques of students used by teachers in modern learning environments are:

- rubric assessment
- self-assessment quiz
- concept map
- portfolio
- peer-assessment
- project
- observation
- diary

5.3.3.1 Portfolio Assessment

The Student Portfolio Assessment is a systematic and specialised collection of student's projects, which have been selected with the consent of the learner and based on specific learning objectives and predefined criteria. These projects are essentially evidence for the student's effort and progress in learning activities[25]. Figure 2 shows the key elements that should be included in a portfolio.

[25] *Chou, N. & Chen, F. (2008). From Portfolio to E-Portfolio: Past, Present, and Future. In K. McFernn et al. (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference, March /(pp. 22-27). Las Vegas, Nevada, USA*

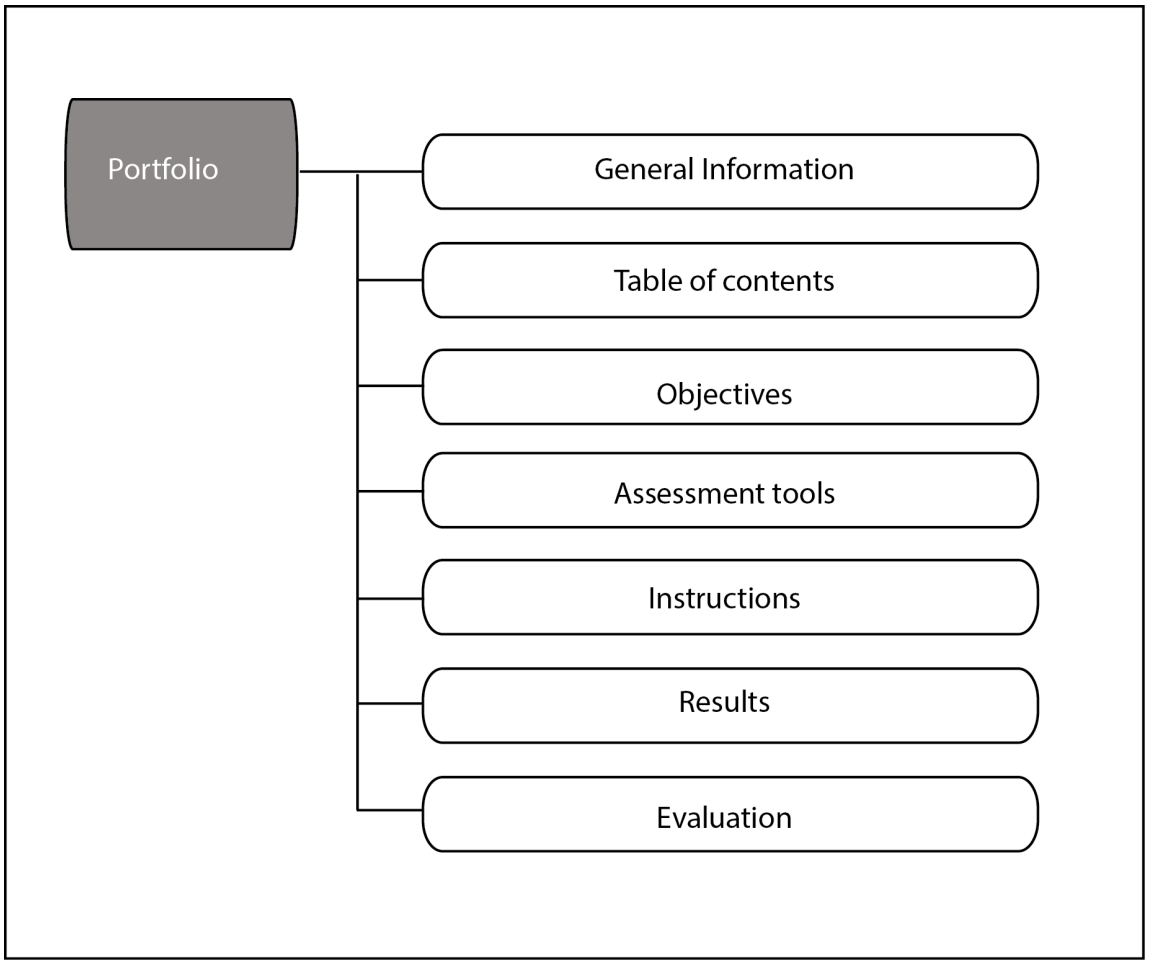

Figure 2 Key elements of a portfolio

In the international literature, multiple classifications of files are recorded, distinguished according to the form they have, the purpose they serve, or even the period they cover. The main categories are:

- Process (or evolutionary) portfolio includes multiple and varied representative samples of the students' work done in a given period, evolvingly reflecting on their learning process and capturing continuous reflection, self-assessment, and self-assessment of the most critical aspects of formative evaluation.
- The scoreboard includes representative samples of the learner's best achievements, such as the best individual or group assignments, the evaluation tests (e.g., tests, competitions) that received the highest performance. The results portfolio is comprehensive compared to the process portfolio and is a reflection of the final evaluation.
- Individual and group files, in educational practice, the most common type of file used to assess the learner is the particular file. The group is used less often / mainly when the teacher engages the students in complex collaborative activities and evaluates the students' group.
- Printed and electronic file, the student's electronic file (e-portfolio) is the digital version of his portfolio, which is paper-based, structured, and organised in a computing environment.

The practical and efficient utilisation of the work file in the daily educational practice as a technique of evaluation of the learner requires the teacher to determine the following:

- The intended teaching objectives and their correlation with the expected learning outcomes
- The contents of the file and its structure in subfolders (the format in subfolders facilitates the students in the process of collecting selection and classification of the most representative items)
- The criteria based on which the items included in the file will be evaluated. The most widely used type of display of standards is in the form of an evaluation rubric
- The period that it will last.

The process of applying the workbook by the student includes the following steps:

- Stage of collection of projects, which are related to the teaching objectives and are evidence for the formation of a detailed and complete picture of the evolutionary course of the learner (e.g., individual or group assignments, exercises, self-assessment tests, reports, progress tests, distinctions, lists of books or learning materials studied, etc.)
- Stage of the selection of the most representative projects, which reflect in the best possible way the achievements of the student and prove the achievement of the expected learning outcomes
- The evaluation stage is considered the most crucial in implementing the portfolio. The students self-evaluate (evaluate their evolutionary course and progress so far), develop metacognitive skills, realise their developmental course, make decisions, set new-future goals and schedules, and make corrections.
- Step of connecting and associating each new item with the ones already integrated into the folder
- Presentation and distribution of the file for the student to receive constructive feedback.

The benefits of applying portfolio-based assessment are noteworthy, both for the learner and the teacher. As a teaching tool, the portfolio encourages students to be actively involved in the learning process. They intentionally choose the assignments to be included in the portfolio so that they reflect their development. Also, students receiving feedback from the teacher can evaluate their learning project's strengths and weaknesses and better understand their progress.

As an assessment tool, the portfolio allows the teacher to "capture" and evaluate the students' progress over a relatively long period, focusing on the execution and application of knowledge and skills.

The learner's electronic portfolio (e-Portfolio) is the digital version of his paper-based work portfolio, structured and organised in a computing environment.

Teachers increasingly use the electronic portfolio (e-Portfolio) as a technique for evaluating their students' performance for all the educational activities [26]. Its growing use in educational practice in recent years has led to the increased availability of commercial and open-source e-Portfolio tools (e.g., Mahara[27] and OSP Open Source Portfolio[28]) in the form of either a database or World Wide Web-based applications. Web). Usually, these applications help teachers and students create hyperlinks between the goals, the outcomes, and the various collected objects of the students presented in multimedia.

[26] *Chou, N. & Chen, F. (2008). From Portfolio to E-Portfolio: Past, Present, and Future. In K. McFernn et al. (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference, March /(pp. 22-27). Las Vegas, Nevada, USA*

[27] https://mahara.org/

[28] http://www.theospi.org/

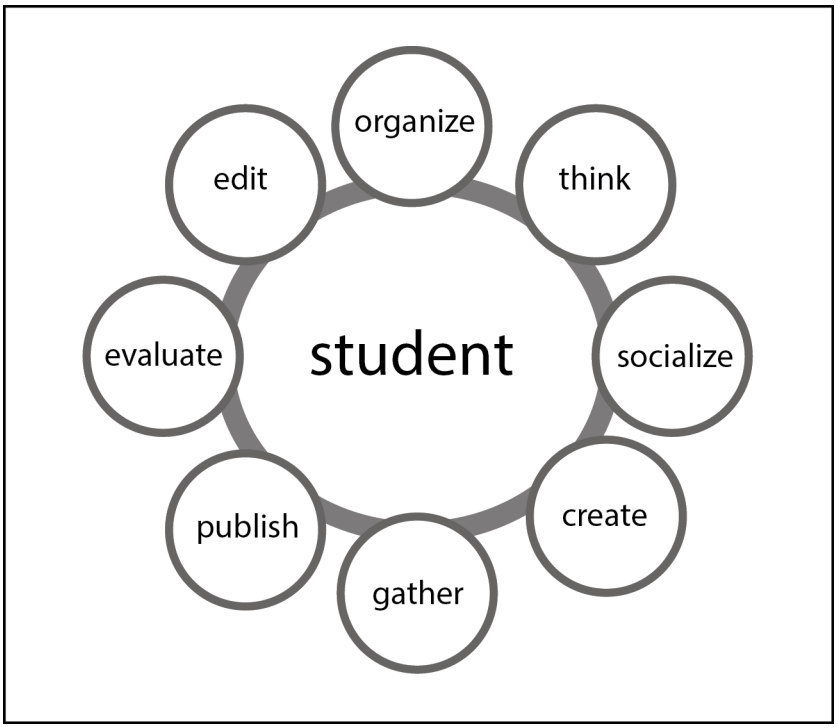

Figure 3 e-Portfolio, a technique for evaluating students' performance

However, despite the significant benefits offered by this technique, in its practical application, the evaluation of the learner based on the electronic file also presents weaknesses, the most important of which are:

- The analysis and evaluation of all data (a large amount of information) in the electronic file is a very time-consuming process for the teacher.
- The data resulting from electronic files' evaluations are challenging to analyse, classify, and reduce this technique's validity and reliability.

5.3.3.2 Peer-Assessment

Peer-assessment is defined as the process by which one or more students evaluate their peers' performance, point out their mistakes, and even suggest ways to improve it [29].

Peer-assessment is primarily considered a learning tool for the learner who conducts the assessment and an assessment tool that focuses on providing feedback. The learner, evaluating his co-workers' work, realises his mistakes and oversights and even reflects on his learning path.

The students' involvement with the evaluation of their co-participants' performance contributes to the development of metacognitive skills, e.g., self-assessment or justification. Also, it contributes to improving the self-monitoring ability, self-knowledge, and, consequently, the learner's self-regulation while strengthening critical thinking, the exercise of a constructive skull, and even decision-making.

Peer-assessment can be used to assess a wide range of knowledge, skills, and skills in various learning objects and activities, in the context of both diagnostic and formative and final assessment. The extremely critical point of this technique is the introduction of the students in the evaluation

[29] *Willey, K. & Gardner, A. (2009). Using Self and Peer Assessment to engage students and increase their desire to learn. 37th Annual Conference of the European association of engineering Education (SEFI). July 1-4, 2009, Rotterdam, The Netherlands*

processes. Its effective implementation requires the teacher to train the students to evaluate their companions based on clear, understandable and commonly accepted criteria.

Note: The effective utilization of peer-assessment presupposes, a) the familiarization of the students with all the learning objectives set by the teacher and with all the criteria that will be used for the evaluation of the learning result and b) with the provision by the teacher of multiple opportunities for practice .

Nowadays, peer-assessment has been widely applied to individual and even group work in modern learning environments that utilise digital technologies. The students engaging in online applications (e.g., e-mail, file transfer, hosting, and even collaborating through shared discussion forums, etc., engage students in peer-assessment lectures) based on commonly accepted criteria (depicted mainly in the form of a rubric accompanying the evaluation with comments or even feedback).

The vital advantage of peer-assessment through electronic evaluation software is to ensure the anonymity of the evaluators-students. However, for students to participate in the peer-assessment process, they must critique, summarise, clarify, provide feedback, recognise errors, or deviations. Otherwise, there is a risk that the evaluative judgments of the students will be arbitrary and subjective.

Despite the declared advantages of this technique, we must point out that for the teacher, the peer-assessment is a very complicated and time-consuming process. It takes enough time to design it, train the participants, and finally process and evaluate the results.

5.3.3.3 Project

The project is considered a very dynamic tool for evaluating students in modern learning environments. The term project research work defines any organised learning activity, usually a collective form, that develops in a free choice with a predetermined plan and aims to explore, collect, and manage knowledge, materials, values, and actions.

The teaching process that utilises the complex tasks of a project is based on the student-centered learning model and focuses on engaging in authentic and experiential activities that involve students (individually and in groups) in problem investigation and decision making, decision making, and scientific research [30]. students are helped by the range of interactions that develop (between students, between students and teacher, between students and learning resources) during the teaching process, are actively and experientially involved in the management of complex tasks, and develop strong cognitive, communicative, and metacognitive skills.

Design, developing, and implementing a complex task is carried out in five phases. The following phases are described in detail:

- 1st phase, during which the problem under investigation is posed by the teacher, initial ideas-hypotheses are formulated by the students, the research questions are identified, etc.
- 2nd phase, during which the students are divided into working groups, the division of the activities that will be undertaken by each group and the undertaking of separate tasks by the members of the group

[30] *Panasan, M. & Nuangchalerm, P. (2010). Learning outcomes of project-based and inquiry-based learning activities. Journal of Social Sciences 6(2) pp. 252-255*

- 3d phase of activities, during which the students take action both individually and through cooperation (e.g., data collection and evaluation and their correlation with the initial assumptions, etc.) for non-investigation of the problem
- 4th phase of presentation and dissemination of the results of the research in front of the class or the wider educational community
- 5th phase in which the groups of students evaluate through self-evaluation and other evaluation: a) the results of the work they prepared, b) the process they followed (methodology, techniques they used), and c) the accomplishment or not of the intended teaching objectives

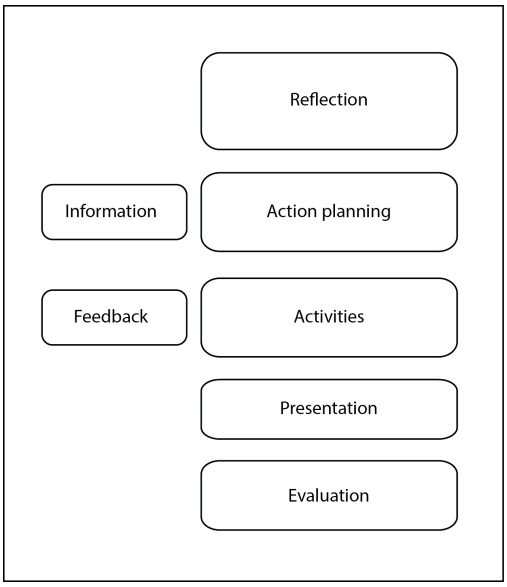

Figure 4 Project design phases

Through the projects, the teacher can evaluate both the learning products (individually-group deliverables that the students go through), the learning process, the student's role, the correlations, and the interactions that develop during the learning process.

5.3.3.4 Observation

In education, teachers' systematic observation is one of the most well-known data analysis techniques and evaluation used by teachers to monitor the learning process's progress and draw conclusions about their students' progress and problems.

In a traditional classroom, the physical presence of a teacher allows him to systematically observe the students and collect data on the degree of their involvement in the learning process (active-passive participation), the effort they make, the interest they show, the initiatives that develop, motivate, shape attitudes, the progress they make, the way they communicate, the problems and weaknesses they face.

In e-learning, because the physical context of the activity changes (we are now referring to an e-classroom where students engage in learning activities through digital tools, exchange messages, learning material, communicate and collaborate either in the same space or remotely), systematic observation and Its corresponding data sources differ significantly.

The main object of observation in e-learning environments is to record how students interact and interact (individually and in a group), the tools they use, the communication and collaboration during the learning process, and how the parameters affect the way and the object of the work they have to perform The data-collection of information is drawn from multiple

sources, such as log files that are automatically stored in the information system and contain information about the interactive activities of the students, video files or even handwritten notes of the teacher, etc.

However, the analysis and evaluation of the multiple and varied data resulting from the students' observation are, for the teacher, a remarkably complex, time-consuming, and complicated task. Especially in e-learning, the teacher to interpret and utilise all the data needs the assistance, guidance, and support of tools that will collect (collect and integrate multiple observation data files), process and correlate the data.

5.3.3.5 Diary

According to the diary technique, the student must record a personal diary for an approved period specified by the teacher.

- the effort he made
- the techniques-tools-tools he used to carry out the activities
- the problems-difficulties encountered (e.g., questions or issues that raised questions and how they were dealt with by the student)
- the cognitive conflicts that led to the understanding of various concepts (e.g., recording miscalculations that pre-existed for a concept, as well as how the learner perceived them
- the assessment of the knowledge or skills acquired (through self-assessment)

The diary is a valuable learning and metacognition tool for the learner and a self-assessment tool that provides feedback and improvement opportunities.

5.4 Mentoring

5.4.1 The use of mentoring in the educational process

Mentoring is a collaborative relationship between two individuals that allows the exchange of views, experiences, information, and practical advice in a field of employment or activity. Mentoring is vital in our program as it leads to the effective management of the learning process and improves students' performance.

The goals of mentoring are the following:

- to offer support, help, and guidance from one experienced person to another with less experience
- to broaden the picture of the socio-economic and educational context in which the specific training program is implemented
- to offer more learning opportunities in a non-threatening environment.

The exact role of the mentor depends on several factors, the most important of which are:

a) in the available time of the mentor

b) the environment and the organisation of the way of working

c) the skills and experience available

d) the needs and interests of the students

e) in the culture of the educational institution that implements the program for utilisation of mentoring processes

For the mentor to be effective in his mentoring-consulting work, it is necessary to have the following characteristics:

- Willingness to provide help-support.
- Communication, collaboration, problem-solving skills.
- Willingness to learn.
- Characteristics of a supervisor

5.4.2 Benefits of mentoring in the field of Education

In the context of an equal relationship between communication and cooperation between the participants in the mentoring process, the benefits are many and essential for all involved.

More specifically, the supervised beneficiaries, the mentor, but also the educational institution in the context of which a mentoring process is developed[31].

5.4.3 The benefit of the supervisor from his participation in a mentoring process

Grisham, Ferguson, and Brink (2004)[32] report the following benefits from the involvement of supervisors in mentoring processes:

- Acquisition of learning opportunities in a non-threatening environment.
- Boosting self-confidence.
- Gaining professional experience.
- Encouragement and support in their work
- Improving teaching skills.
- Development of acceptable practices.
- Acquisition of professional networking and collaboration opportunities.
- Upgrading their position and prestige among their colleagues.
- Limiting the feeling of isolation.

Implementation of mentoring in a distance learning environment

Distance mentoring is an ever-evolving form of mentoring in which the two parts that make up the mentoring relationship are at a distance from each other. Nowadays, when people's mobility is remarkable and the time available is limited, distance mentoring is an advantageous method of providing guidance and counseling support. The rapid technological development of communications now allows us to consider space as the least important factor in developing a mentoring relationship as both parties' physical presence is not required for its development. It should be emphasised that remote mentoring does not negate the importance of personal contact, which is a cornerstone of developing the necessary trust between the two parties.

We suggest the distance mentoring process to be carried out as follows:

Communicates with them by phone at regular intervals on specific days and times. The communication between them will be supported electronically by sending an e-mail. It will be possible to exchange bibliography, supplementary educational material, analyse acceptable educational practices, and resolve questions or questions related to the subject. Student teachers are encouraged to keep diary notes of the difficulties they encountered, the solutions they provided, and the practices they adopted.

[31] *Frangoulis, I., & Balkanos, E. (2011). The contribution of mentoring in adult education: Investigation of perceptions of adult educators in relation to the use of mentoring in the context of their educational work, Lifelong Learning, Interdisciplinary Approaches, Thessaloniki, University of Macedonia Publications.*

[32] *Grisham*, Dana L., Janet L. Ferguson, and Beverly Brink. "Mentoring the mentors: student teachers' contributions to the middle school classroom." Mentoring & Tutoring: Partnership in Learning 12.3 (2004): 307-319.*

All of the above are discussed with the mentor instructor to analyse the teachers' practice's dysfunctional aspects. In all the individual processes, it is recommended to use interactive tools, such as Skype, or a platform like Big Blue Button that allows the mentoring process's visual contact.

5.5 Master Thesis / Practicum

The curriculum offers two options: a Master thesis pathway (research-based) and a non-Master thesis pathway (course-based/placement). Both options have a common aim, to prepare students for employability.

Note: Employability has double definition. For some people the term refers to skills and for others it is a process of preparing individuals for employment.

The structure of the postgraduate program and the possibility for internship aim at further engaging the students in such a way as to enhance employability. More specifically, there is a direct link between the skills acquired and teaching in general and the Employability Programs, as defined by the Academy of Higher Education (2006) [33]. Students formulate personal development plans to reflect on program characteristics and how knowledge and skills relate to the job market through job placement and research. Assessing skills, processes, and experience is how they are recognised as acquired. Thus, in this way, the students enrich their CV and can claim with great demands a job in university and non-university fields.

The research-based pathway enables students to plan and conduct professionally and ethically, produce and disseminate good quality research to solve business problems and issues. The dissertation/project undertaking's primary purpose is to explore the application of Industry 4.0 to one of the four application areas supported by this program. The research needs well-equipped laboratories to help students gain practical skills and experience using special equipment, making links between theory and practice. Also, laboratories give the chance to make calculations, observations, and data analysis in an ideal and suitable environment. As a result, there are all the appropriate conditions for the Master thesis' conduction.

Instead of a Master Thesis, students can choose a placement in key industry and gain insights on how Industry 4.0 concepts can be applied in real-world conditions. Practicum is based on the work-based learning features and processes as described previously. For the practicum to acquire on-the-job training features, it is designed according to the following:

- the development of a network of cooperating companies, which have suitable jobs for the subject of training
- in the analysis of the importance of the internship both to the competent executives of the collaborating companies as well as to the trainers and students of the program
- in the planning of unique activities that will be performed during the internship
- supervising the training of students by specialised trainers, in collaboration with competent business executives
- the evaluation of the internship after its completion, by organising special meetings in the training organisation (analysis in working groups under the supervision of the trainers of the theoretical part and the internship and presentation of the work performed by the students)

[33] *Higher Education Academy (2006) Student Employability Profiles: A Guide for Higher Education Practitioners, The Higher Education Academy, York. Available online at , https://www.advance-he.ac.uk/knowledge-hub/student-employability-profiles . (accessed 29 November 2020).*

- in the evaluation of the results of the internship at the program level.

There is a greater emphasis on practicum because it can prepare students for their future job as their employability awareness is increased. In practice, the most important thing is that students know exactly what they are doing and the practical reason and result. All demanded tools are also provided, allowing them to gain useful experience by using them in practice.

6 Conclusion

To sum up, pedagogical methodology and tools are the basis for a successful program. It is essential to consider all the program's aspects, the learning outcomes, goals, and objectives and decide to use the perfect combination of pedagogic models and teaching methods to have the desired result. In all this process, evaluation and mentoring are two factors that ensure participants' success and satisfaction through the proper organisation and subsequent usefulness of studies, especially in employment or employability.