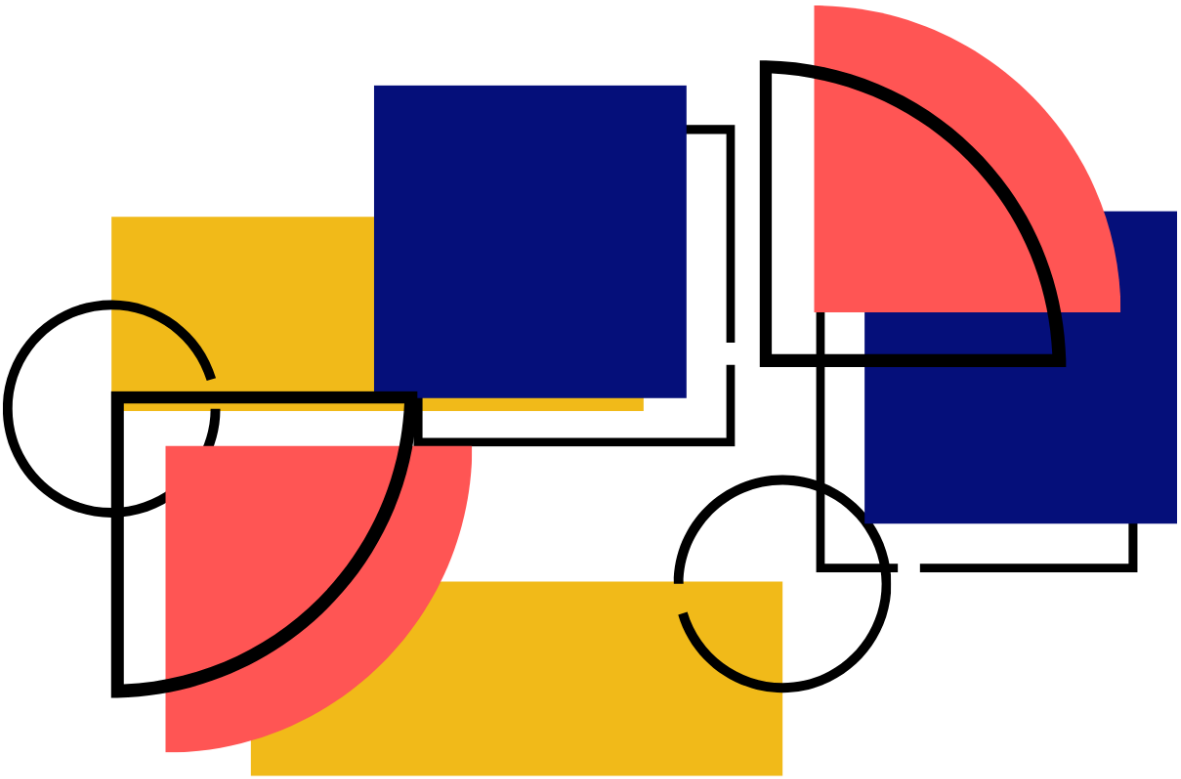
Think4Jobs
Critical Thinking for Successful Jobs

THINK4JOBS

Critical Thinking blended apprenticeships curricula



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Executive summary and key findings

The current Report namely, the third Intellectual Output (IO3) describes 12 Critical Thinking (CT) blended apprenticeships curricula. The development of these curricula was enabled and enhanced through the training that was carried out for Higher Education (HE) Instructors and Labour Market Organisation (LMO) Tutors (IO2). In this training, the participants learned how to promote, develop, support, and assess critical thinking of students in apprenticeships curricula, and how to use the Moodle software to develop a blended course. During this training, a common understanding between HE and LMOs was achieved on the methodology, design and delivery of CT blended apprenticeships curricula. This agreement was sealed by a joint Memorandum of Understanding between every pair of HEI and LMO partners per country. These memorandums specified a specific framework on the expected collaboration between HEs and LMOs for the design and development (IO3), and implementation and evaluation (IO4) of the CT blended apprenticeships curricula.

University of Emden/Leer, Germany (HSEL) was the partner who led the delivery of the IO3. The objectives of IO3 were as follows:

1. Develop and describe 12 CT blended apprenticeship curricula developed in the disciplines of the Think4Jobs project partners: Veterinary Medicine, Teacher Education, Business & Economics, and Business Informatics.
2. Identify common CT aspects that are addressed in the CT blended apprenticeship curricula through University-Business Collaboration (UBC), regardless of the disciplines.

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To reach these objectives, 12 blended apprenticeships curricula were designed, developed, evaluated, and finally implemented as Moodle courses by pairs of HEI and LMO project partners. Based on the descriptions of these courses, common CT aspects that are addressed in the CT blended apprenticeship curricula were identified.

The Critical Thinking Blended Apprenticeships Curricula (CTBAC) presented in the current report contribute to the existing research and literature in numerous ways.

- Firstly, they support and foster the cross-sectoral collaboration between Higher Education Institutions (HEI) and Labour Market Organisations (LMO). The participatory design and development of the CTBAC was established at IO2 and was further enhanced in the current Output, as the courses were established considering the state-of-the-art in the fields of pedagogy and the respective disciplines they addressed. At the same time, the curricula were enhanced as labour market experience and requirements were considered during the design and development of the courses.

- Secondly, these CTBAC provide the opportunity to the learner to engage with computer-supported collaborative and individual learning environments. Students could benefit from a synchronous and asynchronous peer-, group- and instructors led- feedback that aimed to facilitate their reflective thinking. Third, the CTBAC aimed not only to improve CT skills, but also to develop other soft skills that are essential for the labour market such as communication, collaboration, and time management.

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- Finally, CTBAC have a potential for transferability, as they could be further exploited as “templates” for the development of courses that promote knowledge and transfer soft skills in other disciplines.

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Introduction

Critical Thinking (CT) is recognised as a key skill in the progressive and globalised societies of the 21st century. Paired with other soft skills, they ensure the better employability of graduates (Schaeper, 2009). National and governmental organisations and initiatives, such as the Bologna process for education in Europa or the European Network for Accreditation of Engineering Education (2008), have responded to these demands by shifting the focus towards outcomes-based and competency-oriented curricula and defined the development of both disciplinary and transferable skills as a goal for higher education. Society and business see higher education (HE) institutions as responsible for promoting and training CT and other soft skills in their students. Since the development of CT and other soft skills do not automatically go hand in hand with the acquisition of subject-specific knowledge and competence (Abrami et al., 2015), additional effort is needed to meet these demands. Hereby, University-Business Collaboration (UBC) between HE institutions and Labour Market Organisations (LMO) plays an increasingly important role.

UBC is considered essential for various reasons. For instance, Ankrah & Omar (2015) identified in their systematic review that UBC, among others, stimulates technological advancement and enhances innovation, facilitates trainings for students and company staff for the acquisition of the required professional competencies and know-how, creates business and project opportunities to involve students in professional life at an early stage, increases the employability of students and provides business the opportunity to hire talented graduates. Despite the fragmented nature of the UBC literature, scholars have suggested various activities that broaden the conceptualisation of UBC (see EU Commission, 2018).

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In the Think4Jobs project, UBC is the key instrument to achieve the selected project goals such as the development of apprenticeship curricula aimed to train specific competencies and skills in students. Within this collaboration through a joint dialog, LMOs can communicate their requirements for professional qualifications of graduates more easily, while HE institutions can better understand and analyse them.

In each of the five different disciplines - teacher training, English as a foreign language, business economics, business informatics and veterinary medicine, the collaboration between HE institutions and LMO aims the following:

- to create a common understanding of requirements for CT skills that are specific to a particular discipline,
- to design and develop the curricula that explicitly address the improvement of these skills,
- to deliver these curricula within an apprenticeship programme, and
- to conceptualise how LMOs can be engaged at the apprenticeship programme.

At the beginning of the Project, UBC was scaffolded through a joint training for HE instructors and LMO tutors in the course of Intellectual Output IO2. During this training, a common understanding between HE and LMOs was achieved on the theoretical aspects of CT, the methodology, design and delivery of CT blended apprenticeships curricula. As a result of this process, the pair of collaborating partners in each discipline developed a Memorandum of Understanding to specify the steps of the UBC during the design and development process of the CT blended apprenticeships curricula.

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Within the Think4Jobs project, curriculum is defined as “what is taught in the individual unit or subject, and articulated in the unit outline“ (Fraser & Bosanquet, 2016, p.272). In addition, apprenticeship curricula are conceptualised as curricula that include theoretical aspects of a discipline, which are usually delivered by HE Institutions and on-the-job training, which is supervised either by HE Institutions or LMOs. In some disciplines, the implementation of the on-the-job training is supervised by both HE Institutions and LMOs. Thus, appropriately designed apprenticeship curricula meet the needs of both HE institutions and LMOs and enable their close cooperation.

One of the Project requirements is to integrate blended learning in the apprenticeship curricula, which is in line with the priorities of the European Commission regarding the digitalisation of HE (European Commission, 2020). Blended learning is an educational approach that combines the best of online and traditional face-to-face learning methods to make the educational process more efficient (Garrison & Vaughan, 2008). Online learning refers to educational materials and opportunities for interactive learning placed online (Garrison & Vaughan, 2008). Providing blended learning opportunities has proven to be beneficial in time of the Covid-19 pandemic (Gaebel, Zhang, Stoeber, & Morrisroe, 2021).

The Critical Thinking Blended Apprenticeships Curricula (CTBAC) were implemented using the e-learning platform Moodle. Moodle is an open and free learning management system, which will ensure that the CTBAC and the respective materials will be available after the end of the project, increasing the exploitation and sustainability of the Project’s results. Moodle will allow learners and stakeholders

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outside of the Project, to enrol in the courses and receive the materials produced by the UBC in the Project.

In summary the aims of the third current report are (i) to describe the methodology employed and the process of the development of 12 CTBAC in the five different project disciplines, (ii) to identify common CT aspects that are addressed in the CT blended apprenticeship curricula through University-Business Collaboration, and (iii) to provide a link to 12 CTBAC as illustrative examples for educators of how critical thinking skills and dispositions can be developed. These examples describe in detail how pedagogical approaches and instructional methods used can address the development of critical thinking skills and dispositions.

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Methodology

The current section describes the steps that the consortium Partners followed to design and develop the Critical Thinking Blended Apprenticeships Curricula (CTBAC). First, the design principles for the development of CTBAC are presented. The subsequent three sections describe three process phases of the curriculum development: Analysis, Design, and Development.

Design principles

The development of the 12 Critical Thinking Blended Apprenticeships Curricula (CTBAC) in the Think4Jobs project was based on the instructional design process with five core phases: 1) Analyse, 2) Design, 3) Develop, 4) Implement, and 5) Evaluate (ADDIE) that inform each other in the course of the curriculum design process (Branch & Kopcha, 2014). The ADDIE model proved a useful tool for the instructional design process.

The approach of constructive alignment defined by Biggs & Tang (2007) was used as the instructional design model for the development of the 12 CTBAC. This approach relates three central facets of instructional design – 1) intended learning outcomes, 2) learning activities, and 3) assessment tasks. These facets must be aligned, consistent and interconnected (see Figure 1) to ensure that learners achieve the specified learning outcomes and experience learner-centred deep learning.

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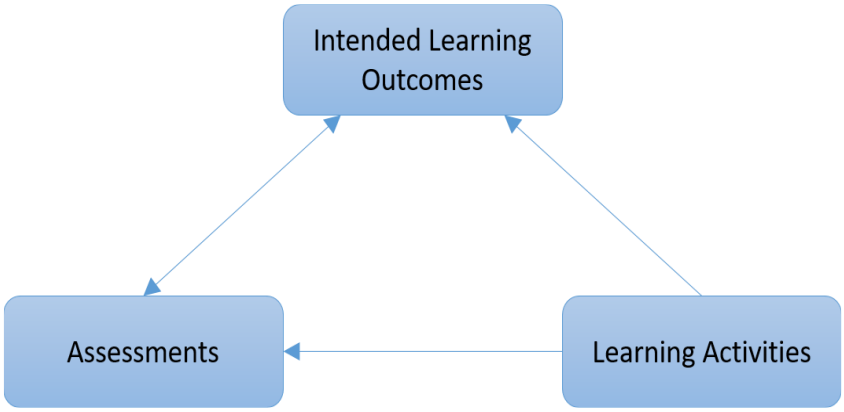

Figure 1: The three central facets of the constructive alignment approach (adopted by Biggs & Tang, 2007)

In the outcomes-driven and competency-based education that the Bologna process strives for, intended learning outcomes are formulated in the form of predetermined competencies, which can be both disciplinary and transferable (Schaeper, 2009). For the Think4Jobs Project, to include CT and other soft skills as intended learning outcomes of the CTBAC is essential. Consequently, they need to be taken into account in the entire instructional design process.

Table 1 lists the activities that were carried out in the five phases of the curriculum design and development process:

Table 1: Activities in the curriculum design process

IO	Phase	Activities
IO3	Analyse	Analyse the requirements for the curricula. Define teaching strategy.

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IO3	Design	Design the curricula using the selected instructional design model. Specify learning outcomes in the form of competencies. Introduce a learning scenario. Describe learning activities and assessment tasks.
IO3	Develop	Review and refine the curricula. Create the required resources and materials to support learning in the curricula. Prepare the curricula on Moodle.
IO4	Implement	Deliver the curricula.
IO4	Evaluate	Conduct pre-, middle-, and post-tests of students. Analyse the students' responses and present the results.

The following sections describe the three phases of the curriculum development process that are relevant to the current Intellectual Output IO3.

Analysis

In this section, the requirements for the Critical Thinking Blended Apprenticeships Curricula (CTBAC) are analysed first, then the teaching methodology is specified.

The analysis of the project proposal resulted in following three requirements for CTBAC:

1. CTBAC must address critical thinking skills and other soft skills such as communication, collaboration, and time management. Critical thinking skills

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were defined per discipline in the Memorandums of Understanding in the course of the Intellectual Output 2.

2. CTBAC must be designed and implemented to support blended learning.

3. CTBAC must offer the students a computer-supported collaborative and individual learning environment based on the Moodle e-learning platform.

Since critical thinking and soft skills are effectively and efficiently trained together with the subject-specific skills rather than in separate courses (Schaeper, 2009), the following requirements for CTBAC were added:

4. Critical thinking and other soft skills need to be included in the intended learning outcomes of CTBAC.

5. Instructional methods targeting the development of critical thinking and soft skills in students need to be integrated in the course design and aligned with the pedagogical approaches used for teaching a particular discipline. It also needs to detail the specific content that supports the development of these skills .

To address these requirements and align teaching and learning to the applied instructional design model, the constructivist view of learning (Slavin & Davis, 2017) has been employed as the foundation for the instructional design. Its main idea is that knowledge and understanding cannot be transmitted from teacher to students. Learners construct a knowledge base on their own cognitive structure and individual experience. For this, they discover and apply their own ideas, experience things and reflect on these experiences.

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Design

In this phase of the instructional design process, the following activities were carried out by the consortium Partners:

1. The curricula were designed and described using the selected instructional design model.
2. Learning outcomes including subject-specific competencies, critical thinking and other soft skills were specified.
3. Learning scenarios that were originally introduced in Intellectual Output IO1 were described.
4. Learning activities and assessment tasks were specified.

Based on the instructional design model used, a template for curriculum design (see section Curriculum description template in Appendix) was developed to describe all blended apprenticeship curricula. This template contains the following sections:

- A curriculum description that includes the syllabus and a visual representation of the curriculum. The visual representation is developed in accordance with the principles of the instructional tool “Advanced Organiser” (Ausubel, Novak, Hanesian, & others, 1968).
- Specification of intended learning outcomes, which include subject-specific competencies, critical thinking and soft skills.
- Specification of the learning activities that will be offered to students.
- Specification of the assessment tasks to evaluate the acquired competencies.
- A learning scenario as a rich example of how the selected critical thinking and soft skills need to be concretely addressed.

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The consortium Partners used this template to design and describe the 12 Critical Thinking Blended Apprenticeships Curricula. The following subsections describe the main sections of the course design template in more detail.

Specification of intended learning outcomes

The main goal of a curriculum is the acquisition of subject-specific knowledge and skills. They are indispensable for each subject and cannot be compensated through well-developed transferable skills (Weinert, 1998). Subject-specific knowledge and skills need to be specified as intended learning outcomes in a separate section of the course design template.

Along with the subject-specific knowledge and skills, critical thinking and soft skills need to be specified as intended learning outcomes in other separate sections. While knowledge and skills are specific for each subject, critical thinking and soft skills can be defined more broadly. For example, Facione (1990) has developed a framework that lists and describes skills and dispositions, which are characteristic for the ability of critical thinking. This framework provides a foundation for the definition of critical thinking skills and attitudes as intended learning outcomes in the curriculum design template.

Specification of learning activities and assessment tasks

Since critical thinking and soft skills should be trained together with the disciplinary skills, learning activities must be designed and implemented to address all these skills. Two teaching approaches that emphasise the integration of critical thinking skills in a disciplinary context were proposed to be used for the course design: the infusion

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approach and the immersion approach. Both approaches embed critical thinking skills into the regular curriculum. The major distinction between these approaches is that in the immersion approach, the principles of critical thinking are not made explicit (Prawat, 1991). It is assumed that a deep understanding of content is both a necessary and sufficient condition for the development of critical thinking. According to the constructivist view on learning and teaching, student-centred pedagogical approaches were applied in this project to develop the proposed curricula, namely the problem-based and project-based learning. Active learning strategies such as group work, discussions, debates, brainstorming, were integrated in the curriculum design.

Learning activities were organised within individual learning sessions according to the sandwich design principle (Kadmon, Strittmatter-Haubold, Greifeneder, Ehlail, & Lammerding-Köppel, 2008). According to this principle, learning sessions are divided into several blocks, which contain short content-related theoretical presentations (about 15-20 minutes), learning activities in small groups such as discussions and group work, and individual work.

Specification of learning scenarios

Critical thinking competencies may be developed in problem related contexts. Therefore, learning scenarios were developed with specific learning activities that called for the mobilisation of critical thinking competencies along with disciplinary competencies and skills to succeed. The learning scenarios are concrete and rich examples of how the selected critical thinking skills should be addressed in instruction and learning. They include a clear description of the task students have to work with, the scenario-specific intended learning outcomes connected with this task, scenario-

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specific concrete learning activities, and assessment. These elements are specific for a concrete scenario and correspond to its duration.

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Development

In this phase of the instructional design process the following activities were carried out by the consortium Partners:

1. The curricula were evaluated through a review process and refined.
2. The required resources and materials to support learning were created.
3. The curricula were prepared on Moodle, the priority was given to the courses started in the autumn semester.

Once designed, the curricula were evaluated and refined. The evaluation process will be described in the next section. The next step was to develop the necessary learning materials to meet the design of the curricula. Finally, the curricula were implemented on Moodle.

Evaluation of the curriculum design

To ensure the consistency and quality of the designed Critical Thinking Blended Apprenticeships Curricula (CTBAC), internal pairwise peer- reviews of the curriculum designs were considered as an appropriate method for evaluating the proposed curricula. These reviews aimed to examine whether the intended learning outcomes, the learning activities, and the processes employed for student assessment were coherent and aligned in each curriculum. In addition, the pairwise evaluation focused on the aspects of CT rather than the disciplinary knowledge addressed in each curriculum. Moreover, the designed curricula were evaluated for credibility, consistency, and clarity. Reviewers provided their remarks in case of an identified discrepancy. Finally, the Coordinators of the Intellectual Output, namely the University of Applied Sciences Emden/Leer (HSEL) in Germany, reviewed the post-

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reviewed files for the 12 curricula proposed and provided further feedback to the Project partners.

In the case of the Greek curricula, apart from the internal review, an additional peer review process was carried out. In this review, three external experts evaluated the three developed curricula. These experts were teaching staff of other universities in the specific subjects addressed in the curricula, namely Science Education, Study of the Environment and Didactics of Biology. At the end of the review process, authors of the curricula modified their curriculum designs in order to meet the review requirements.

To conduct the internal review of the curricula, a review template was developed and provided to the Partners (see Curriculum design review in Appendix). The review template consisted of two parts. The first part explained step-by-step how the review process should work. The second part provided an evaluation matrix to support the evaluation. Three main process steps were specified for conducting the internal review: (1) completing the review matrix by authors, (2) conducting the review, and (3) processing review comments to refine the curriculum. Specifically, during the preparation of the review, the curriculum authors completed the evaluation matrix by aligning the intended learning outcomes, learning activities, and assessment tasks of their curriculum. The curriculum design document and the evaluation matrix were then shared to the reviewers. During the review, the reviewers went through the evaluation matrix, critically analysed whether intended learning outcomes, learning activities, and assessment tasks are coherent and aligned, and provided their comments. Subsequently, the authors analysed these comments and refined their curriculum designs.

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Implementation of the curricula in Moodle

The evaluated curriculum designs were implemented in Moodle. Learning activities, including those for blended learning, were realised using the existing Moodle tools and features. Learning materials were developed in local languages and were uploaded on Moodle. In some cases, the materials were in English as the curriculum was for international program studies (e.g., Lithuania).

Common Aspects of Critical Thinking

This section is aiming at presenting a comparative analysis of the 12 Critical Thinking Blended Apprenticeships Curricula (CTBAC), which were developed through University-Business Collaboration (see Table 2). In particular, the analysis focused on four pillars that were common among the curricula such as (i) the CT related learning outcomes, (ii) the learning activities offered to the students, (iii) the assessment tasks, and (iv) the learning scenarios introduced to specifically address CT skills.

The majority of the consortium partners claim to address a majority of the CT skills and dispositions defined by Facione (1990) or other CT related frameworks (e.g., Ennis, 1964; Halpern, 2003; Paul & Elder, 2008) in their curricula. An exception of this can be seen in the German curricula that address selected skills.

The Critical Thinking Blended Apprenticeships Curricula described by the consortium partners use similar learning activities to train disciplinary competencies, CT and other soft skills. These learning activities are based on active learning instructional methods such as problem solving, discussion, group and individual work and presentation. The partners seamlessly integrate the training of CT and other soft skills into the activities

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intended to develop disciplinary competencies. In most curricula teachers do not explicitly present CT skills to the students. This is explicitly done only in the three Greek curricula in which teachers present various definitions of CT and explicitly mention CT skills and dispositions to be trained.

Similar methods were used in the curricula to assess students' disciplinary competences. The most common assessment method exploited was the presentation of the results of the work carried out by students on a task. This assessment method was followed by a written exam, essay and written product documentation.

An aim of this Intellectual Output IO3 was to present concrete learning scenarios as part of the curricula to show how consortium partners addressed the development of CT and other soft skills in the students. Although the presented scenarios deal with subject-specific topics and are generally different, most of them share several common aspects:

- Pedagogical approaches and instructional methods used to develop CT and other soft skills support active learning of students.
- Learning scenarios offer the students concrete subject-specific problems or tasks that students need to independently solve while working in groups. These problems are located on the high cognitive levels of intellectual abilities and skills defined by Bloom in the taxonomy of cognitive domain (Anderson & Krathwohl, 2001).
- The problem or task is usually given to students at the beginning of the curricula and is processed during the entire module. Less frequently it consists of multiple smaller activities distributed throughout the semester.
- The students are supported by instructors at various activities:

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- presentation of the theoretical content needed,
- organised learning activities such as discussions,
- continuous feedback of instructors.

- The students present the results of their work at the end of the curriculum or at the end of the activity, which are assessed and included in the final grade.
- CT and other soft skills are assessed along with the disciplinary skills as the students conduct some learning activities such as discussion, or as a result of their work on the task or problem solving.

The methodological differences between the learning scenarios can be summarised as follows:

- The subject-specific problems or tasks offered to the students in learning scenarios address different cognitive levels of Bloom's taxonomy. In some curricula, for example "Business Communication", "Deontology", and "Imaging", students need to analyse and evaluate a situation or use case (fifth cognitive level), while in other curricula, for example "Economic Aspects of Industrial Digitalization", "Teaching of the Study of the Environment", "Virtual Learning Environments in Economics" students need to create or construct their own product (the highest cognitive level).
- In the "International Relations and Political Science" and "Childhood Pedagogy" curricula, students need to conduct research on a specific topic, write a recommendation proposal, and defend it.
- In some curricula, in particular those which deal with didactics, the students work on the task or solve the problem individually.

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- Depending on the curricula, various assessment methods are used to assess the students' CT skills. In some curricula, for example, "Pedagogy of Economics" specific checklists are used by teachers to assess CT skills by students' observation during the learning activities. In several curricula, for example of Portuguese and Greek partners, the use of specific rubrics to score Critical Thinking skills was proposed

Table 2 summarises various CT aspects across the respective curricula.

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Table 2: Summary of CT aspects addressed in the curricula

Curriculum	CT skills	Learning activities	Assessment tasks	Summary of the Learning scenario
Romanian curricula				
Virtual Learning Environments in Economics	CT skills: • Interpretation • Analysis • Inference • Evaluation • Explanation • Self-regulation CT dispositions: • Truth-seeking • Open-mindedness • Analyticity	• problem-based learning • discussions • group work • individual work	The assessment takes place at the end of the semester: students present their lecture sequences using the interactive platform. Critical thinking aspects considered by the assessment: analysis, explanation, systematicity, self-regulation, self-confidence.	The development of a virtual learning environment using Google sites solution for a discipline chosen by the student. Starting from a theoretical foundation, using case studies and examples of good practice, students create their lecture sequences on an interactive platform that will ensure the best conditions for educational activities (teaching, learning and assessment) in the virtual environment. • Takes place during the entire course • Self-guided learning

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	• Systematicity • Self- confidence • Inquisitiveness • Cognitive maturity			• Parallel teaching activities with case studies and debates • At the end – presentation of results
Business Communication	CT skills: • Interpretation • Analysis • Inference • Evaluation • Explanation • Self-regulation CT dispositions: • Truth-seeking • Open-mindedness	• discussions • group work • individual work • hands-on learning • reciprocal teaching • cooperative learning • debate	• oral evaluation during the semester • essay about business communication • systematic observation of the way students work • project (business proposal)	Several case studies are carried out during the course. An example of a Case study: Difficult communication in a project.

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	• Analyticity • Systematicity • Self-confidence • Inquisitiveness • Cognitive maturity			
Pedagogy of Economics	CT skills: • Interpretation • Analysis • Inference • Evaluation • Explanation • Self-regulation CT dispositions:	• discussions • group work • individual work • case studies • learning by doing • learning by self-discovery	• checklists • ranking lists • learning scenario is included in the final examination • essay on learning scenario	The LMO presents a training session where the students are in trainee roles. The next 2h are dedicated to the teacher perspective. The students discover methods, teaching approach, materials, instruments used by the trainer. Students design three learning scenarios for concrete lessons. They explain how and why the

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	• Truth-seeking • Open-mindedness • Analyticity • Systematicity • Self-confidence • Inquisitiveness • Cognitive maturity	• cooperative learning		methods chosen for the scenarios help achieve the learning outcomes of the lessons.
Lithuanian curricula				

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International Relations and Political Science	CT skills: • Interpretation • Analysis • Inference • Evaluation • Explanation • Self-regulation CT dispositions: • Truth-seeking • Open-mindedness • Analyticity • Systematicity • Self- confidence • Inquisitiveness	• debating on various national and international political issues • a critical discourse analysis • research on a specific political topic • writing a research proposal • presentation of research proposals.	• research-based essay writing • debates • team project presentation	Make a critical evaluation of the quality of teaching in primary schools in Lithuania and present their research results and propose recommendations to the Lithuanian Ministry of Education, Science and Sports in the form of a research proposal and a conference talk.

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Childhood Pedagogy	CT skills: • Interpretation • Analysis • Inference • Evaluation • Explanation • Self-regulation CT dispositions: • Truth-seeking • Open-mindedness • Analyticity • Systematicity • Self- confidence • Inquisitiveness • Cognitive maturity	• task-based and action-oriented learning methods • discussion • debates • project work • case studies • essay writing • research proposals • reflection	• research-based essay writing • discussion of students by answering the audience questions • team project presentation	The development of critical thinking skills of students in primary, secondary, and tertiary education is of vital importance. Teachers have to be ready to apply suitable methods and to create favourable teaching /learning environment and apply suitable teaching strategies for the development of critical thinking skills of students at all levels of education. Lithuania schoolchildren do not score high on the development of higher-order thinking skills on international tests, therefore, it is necessary to find out how much research has been done in Lithuania about the development of critical thinking in primary education, specify the problems in this area, and provide solutions how

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				to improve schoolchildren's critical thinking skill development. Overall scenario for the students of the Childhood Pedagogy study program: students are members of a university research team. Their aim is to make a critical evaluation of the quality of teaching critical thinking in primary schools in Lithuania and to present their research results and propose recommendations to the Lithuanian Ministry of Education, Science and Sports in the form of a research proposal and a conference talk.
German curricula				
Economic Aspects of	CT skills: • Interpretation	• discussions • group work	• written exam	The development of a novel business model in the field of industrial digitalization. Based on the

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Industrial Digitalization	• Analysis • Evaluation • Explanation CT dispositions: • Truth-seeking • Open-mindedness • Analyticity • Systematicity • Self- confidence	• individual work • learning scenario • presentations • self-studies	• presentation of the Business model • Business model document	theoretical foundations, case studies and discussions in class, students have to develop a novel business model that meets the requirements of industrial digitalization. The business model developed should focus on at least one of the areas listed in the curriculum. • Takes place during the entire course • Self-guided learning • Parallel teaching activities with case studies and debates • At the end – presentation of results
Design Patterns	CT skills: • Interpretation • Analysis • Evaluation	• problem solving • group work / pair programming • individual work	• presentation (will be 10% of the final grade)	In this learning scenario, the application of the design pattern “singleton” for a given software development problem situation is trained. Students analyse a software development

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	• Explanation CT dispositions: • Open-mindedness • Analyticity • Systematicity • Self- confidence	• discussions • presentations • self-studies • learning by doing	• audible self-reflection during the discussion after the presentation • exam (50% of the final grade) • documentation (30% of the final grade) • observation by the tutors (the Holistic Critical Thinking Scoring Rubric-HCTSR is used)	problem described in the software requirements specification (Interpretation, Analysis, Evaluation, Systematicity, and Analyticity). Based on this, the students specify and identify possible solutions for the given problem and discuss them with their peers and tutors (Self-confidence, explanation, open-mindedness, systematicity). Thereafter, the students select the best possible solutions (Evaluation).
Greek curricula				
Didactics of Science Education	CT skills: • Interpretation • Analysis	• face-to-face lecturing	• written and oral tasks in class	The course is divided in two parts: a theoretical (Teaching Models) and practical (design lesson plans for elementary school students, improve

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	• Inference • Evaluation • Explanation • Self-regulation CT dispositions: • Open-mindedness • Systematicity • Self- confidence • Inquisitiveness • Cognitive maturity	• design and preparation of lesson plans • mentoring • teaching practice observation • reflection • critical discussion • brainstorming • work in groups • content creation	• the participation in Moodle-based activities (i.e. peer assessment of experiment preparation prior to teaching as well as peer feedback after teaching and discussion boards) • final exams • Students' self-assessment of CT skills CT skills and dispositions are assessed using a rubric.	their lesson planning skills and teaching preparation skills).
Didactics of Biology	CT skills: • Analysis	• presentations • in-class discussions	• peer assessment of the practical part	The course is divided in two parts: a theoretical (Teaching Models) and a practical part (design

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	• Evaluation • Self-regulation • Reflection CT dispositions: • Truth-seeking • Open-mindedness • Systematicity • Inquisitiveness • Cognitive maturity • Intellectual courage	• individual work • chatting • forum discussion • peer reviews	• written feedback to their fellow students CT skills and dispositions are assessed using a rubric.	lesson plans for early childhood students, improve students' lesson planning and teaching preparation skills). In the practical part, students work autonomously in pairs. At the end, they present the results. Students receive feedback for their work from their mentors, instructor, and peers.
Teaching of the Study of the Environment	CT skills: • Analysis • Evaluation • Self-regulation	• presentations • in-class discussions • individual work • group work	• peer assessment of the practical part	The course is divided in two parts: a theoretical (Instructional methods and strategies for the field of the Study of the Environment) and

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	• Reflection CT dispositions: • Truth-seeking • Open-mindedness • Systematicity • Inquisitiveness • Intellectual courage	• chatting • forum discussion • peer reviews	• written feedback to their fellow students CT skills and dispositions are assessed using a rubric.	practical (design lesson plans for elementary school students, improve their lesson planning. In the practical part, students design and implement Teaching Learning Sequences. At the end, they present the results. Students receive feedback for their work from their mentors, instructor, and peers.
Portuguese curricula				
Deontology	CT skills: • Interpretation • Analysis • Inference • Evaluation	• case-based learning • argumentation and critical debate	• presentation • written products • discussion • written exam	Students work in groups of 5 people, created randomly. Three activities were proposed. In the first, addressing Animal Ethics concerns, each group receives one published article to read and

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	• Explanation • Self-regulation CT dispositions: • Truth-seeking • Open-mindedness • Analyticity • Systematicity • Self- confidence • Inquisitiveness • Cognitive maturity	• problem-based learning • discussions • group work • individual work • learning scenario	For the assessment of written products, a VALUE rubric will be used	discuss. Each group constructs the pro and con's arguments, identifying different interest stakeholders, and presenting their group conclusions. Groups hold presentations that are discussed in plenary. The groups defend their conclusions based on ethical arguments. In the second activity students are requested to analyse and debate an ethical dilemma around Bioethics Students need to identify moral and ethical concerns, discriminate between different points of view or positions and construct a voice representing the group position in that dilemma. In the third activity, students must analyse a situation issued from the professional activity for the veterinarian professional conduct, decide about putative deviations towards the

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				professional code and decide on a penalty, if deemed necessary.
Imaging	The same	• critical discussion	• written questionnaires for assessing the in-group discussion • written products • written exam For the assessment of written products, a VALUE rubric will be used	Three learning scenarios in the semester that cover three topics: Radiology, Ultrasonography, and Magnetic Resonance Imaging and Computed Tomography. The students will be faced with a clinical episode that resulted in lesions of anatomical structures in a dog, observable in the X-Ray exam. The students will have to clearly analyse the animal's clinical status and eventual life-threatening conditions, and it will be asked to the students to perform an abdominal X-Ray diagnostic exam on the animal.

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The final outputs of the instructional design process described in the section Methodology, namely the Critical Thinking Blended Apprenticeships Curricula, which were developed by University-Business collaboration of HEIs and LMOs in the five countries of the Consortium, are presented in the following table (see Table 3).

Table 3: HEI and LMO Partners and 12 curricula

HEI and LMO Project Partners	**Curricula**	**Direct link**
University of Évora (UÉvora) Hospital Veterinário Atlântico (HVA)	Deontology	https://docs.google.com/document/d/154LjXE8Le1ZKYhSzjpenS2OhyWcf5xfQ/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
	Imaging	https://docs.google.com/document/d/16yzcJz5VjTpk2IHa9z6siLsyhr2d-BLi/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
	Gyneacology, Andrology and Obstetrics[1]	https://docs.google.com/document/d/1EL0-m-2YStvxKT7IMPeCzGOtihtD2RA5/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true

[1] This curriculum was designed in addition to the 12 curricula required according to the Project's agreement.

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University of Western Macedonia (UOWM) Elementary Experimental School of Florina	Science Teaching	https://docs.google.com/document/d/1_AKYuuM1qZUwx1RplLyzLT5MAOh6waDG/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true
	Didactics of Biological and Environmental Concepts	https://docs.google.com/document/d/1s6lXKz4iNoT82fpb4OQkys4PgSsBqIEV/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true
	Teaching of the Study of the Environment	https://docs.google.com/document/d/15oBi3MpIkssrOuNRY2GpVrqwYMhJoT1h5kxfa9zKv7Q/edit?usp=sharing
University of Applied Sciences Emden-Leer (HSEL) Orgadata AG (Orgadata)	Economic Aspects of Industrial Digitalization	https://docs.google.com/document/d/1V0t_9jzs-_O36pJTZGC9mrfJkAmp-S_e/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
	Design Patterns	https://docs.google.com/document/d/14l7CAg2PRZe9iQ1ARxc5Wsp9BnWeg84e/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
Vilnius University (VU) Public Service	International Relations and Political Science	https://docs.google.com/document/d/13mwQruOWbYbzKxIaGEAtkvEVcXvoQaOS/edit?usp=sharing&ouid=1036303686145

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Language Center (VIKC)		85416428&rtpof=true&sd=true
	Childhood Pedagogy	https://docs.google.com/document/d/166gRo0WNxyDMiONy7eiNGOsZNZFHCRRI/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true
Bucharest University of Economics Studies	Virtual Learning Environments in Economics	https://docs.google.com/document/d/1dbSpYkdwz8FmHcMTKzqHOCIr0mD9_tY8/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
	Business Communication	https://docs.google.com/document/d/1gS4dLPHJnFe2PdicSS5-HvzZfblR75Qe/edit?usp=sharing&ouid=117708009014041202729&rtpof=true&sd=true
	Pedagogy of Economics	https://docs.google.com/document/d/1XIbCxbyjjVgvNl-_aXzADTb4-oFUZpBZ/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true

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Discussion and Future Steps

The current report is summarising the instructional design of the 12 CT blended apprenticeships curricula, which were designed and developed to meet the aims of the third Intellectual Output (IO3) of the Think4Jobs Project. Among the innovative aspects of IO3 is that it supports and fosters the cross-sectoral collaboration between HEI and the labour market for the collaborative development of the CT blended apprenticeships curricula. In particular, Think4Jobs, is to our knowledge, the first Project that engages HE and LMO Partners in a joint effort of curriculum design and development in order to address the skills gap particularly for CT. Another innovative aspect of IO3 is the exploitation of the apprenticeships, which is deemed appropriate not only because CT can be promoted (Abrami et al., 2015), but also because it is a cross-cutting point, where HE and LMOs needs and requirements meet. An additional innovative aspect is the integration of blended learning aspects in the CT blended apprenticeships curricula exploiting the open course management system, Moodle. Although blended learning was originally considered, within the Project, important for the digitalisation of HE, the Covid-19 pandemic rendered this aspect of the curricula more prominent than ever. Further, an innovative aspect of IO3 is that the templates developed for the design of the curricula can easily be replicated and exploited for other disciplines and for promoting additional soft skills apart from CT.

Drawing on the 12 CT blended apprenticeships curricula, we highlight that common to all curricula is that an appropriate task is applied to develop CT skills. The task has inherent challenges, the solution of which requires students to trigger CT skills and dispositions. Common to the challenges is that either there is no single “correct” solution, or it is not obvious, i.e. it is hidden and needs to be discovered during the

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solution of the task. The latter seems especially relevant when the task requires cognitive abilities located at the highest level of Bloom's taxonomy.

In this study, there was a limitation related to IO3: the 12 CT blended apprenticeships curricula were not piloted by the students due to the tight project planning related to the development and deployment of these curricula. However, the quality of these curricula was established through the peer review process.

The next two final phases of the instructional design process – Implementation and Evaluation – of the Critical Thinking Blended Apprenticeships Curricula will be dealt in the Intellectual Output IO4. The “Implementation” phase includes the delivery of the developed curricula, while the “Evaluation” phase contains three measurements of students’ perception – surveys to be conducted pre-, during-, and post-curriculum delivery.

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Appendix

Type of Document	Link
Curriculum description template	https://docs.google.com/document/d/15ys5JY6pTYoq5lNmufaKWfZGb1zdh02D/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true
Curriculum design review template	https://docs.google.com/document/d/1G36Zfhyh94LdL2K3vwgYvrJrJcOzJz5x/edit?usp=sharing&ouid=103630368614585416428&rtpof=true&sd=true

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